

TROUBLESHOOTING COMMUNICATION RECEIVER

\$1.55 FEB. 1979

Radio INC Electronics

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

SOLAR TRACKING SYSTEM

A guide to building a system that controls solar energy panels so they track the sun.

WIRE WRAP JUNGLE

New construction technique combines PC and wire-wrap assembly to get the best of both worlds.

AUDIO TEST STATION

Construction details for a high-quality audio test instrument that combines several important test instruments into a single cabinet.

CASES AND CABINETS

A roundup of commercially available off-the-shelf enclosures that add a professional look to your projects.

PLUS:

- ★ Two Hi-Fi Test Reports From R-E's Audio Lab
- ★ New IHF Amplifier Standards
- ★ Jack Darr's Service Clinic
- ★ State-Of-Solid-State
- ★ Computer Corner
- ★ Hobby Corner
- ★ CET Test

Build A Pro Quality
STRING SYNTHESIZER
It's A Bargain



RETAILER: SEE PAGE 97 FOR
SPECIAL DISPLAY ALLOWANCE PLAN





The President base station. In the manner to which you've become accustomed.

People have come to associate superb quality with President CB.

And rightly so. When we build a base station, we go all out.

Every President base station is a masterpiece of performance, with a full complement of controls and indicators for your enjoyment of CB at its absolute best.

The Madison is a good example: the finest 40 channel base yet achieved by the President engineering art.

It's a single sideband CB, with a full 4 watts output on AM, 12 watts peak envelope power on single sideband for extraordinary performance, range and total talkpower.

Despite unsurpassed receiver sensitivity, bleedover just isn't a problem. Our adjacent channel rejection sets a standard for the industry. And you can set your own standard of sensitivity with a variable RF gain control.

A digital clock turns on the radio at a pre-selected time. An alarm reminds you of scheduled calls.

Two big meters read signal strength received, relative RF output, modulation and standing wave ratio.

There's a digital LED channel indicator. Three more LEDs to indicate when you're on upper sideband, lower sideband or AM. Still another LED glows when you're transmitting.

A built-in variable mike gain control eliminates the need for a separate power mike.

We've even given the Madison's big speaker its own separate cabinet, so you can put it where it sounds best.

Your local CB specialist is the place to find President equipment. Plus the best in accessories and service, including installation, warranty back-up and the

most expert advice in town.

Ask him about the new Madison base station.

It's unequivocally President.

In the grand manner.



PRESIDENT

Engineered to be the very best

President Electronics, Inc.

16691 Hale Avenue - Irvine, CA 92714 - (714) 556-7355

In Canada: Lectron Radio Sales Ltd., Ontario

CIRCLE 38 ON FREE INFORMATION CARD

The Age of Affordable Personal Computing Has Finally Arrived.

Ohio Scientific has made a major breakthrough in small computer technology which dramatically reduces the cost of personal computers. By use of custom LSI micro circuits, we have managed to put a complete ultra high performance computer and all necessary interfaces, including the keyboard and power supply, on a single printed circuit board. This new computer actually has more features and higher performance than some home or personal computers that are selling today for up to \$2000. It is more powerful than computer systems which cost over \$20,000 in the early 1970's.

This new machine can entertain your whole family with spectacular video games and cartoons, made possible by its ultra high resolution graphics and super fast BASIC. It can help you with your personal finances and budget planning, made possible by its decimal arithmetic ability and cassette data storage capabilities. It can assist you in school or industry as an ultra powerful scientific calculator, made possible by its advanced scientific

math functions and built-in "immediate" mode which allows complex problem solving without programming! This computer can actually entertain your children while it educates them in topics ranging from naming the Presidents of the United States to tutoring trigonometry all possible by its fast extended BASIC, graphics and data storage ability.

The machine can be economically expanded to assist in your business, remotely control your home, communicate with other computers and perform many other tasks via the broadest line of expansion accessories in the microcomputer industry.

This machine is super easy to use because it communicates naturally in BASIC, an English-like programming language. So you can easily instruct it or program it to do whatever you want, *but you don't have to*. You don't because it comes with a complete software library on cassette including programs for each application stated above. Ohio Scientific also offers you hundreds of inexpensive programs on ready-to-run cassettes. Program it yourself or just enjoy it; the choice is yours.

Ohio Scientific offers you this remarkable new computer two ways.

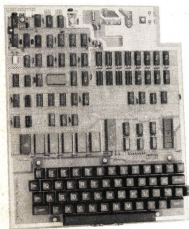
Challenger 1P \$349

Fully packaged with power supply. Just plug in a video monitor or TV through an RF converter to be up and running.



Superboard II \$279

For electronic buffs. Fully assembled and tested. Requires +5V. at 3 Amps and a video monitor or TV with RF converter to be up and running.



Standard Features

- Uses the ultra powerful 6502 microprocessor
- 8K Microsoft BASIC in ROM
 - Full feature BASIC runs faster than currently available personal computers and all 8080-based business computers.
- 4K static RAM on board expandable to 8K
- Full 53-key keyboard with upper/lower case and user programmability
- Kansas City standard audio cassette interface for high reliability
- Full machine code monitor and I/O utilities in ROM
- Direct access video display has 1K of dedicated memory (besides 4K user memory), features upper case, lower case, graphics and gaming characters for an effective screen resolution of up to 256 by 256 points. Normal TV's with overscan display about 24 rows of 24 characters; without overscan up to 30 X 30 characters.

Extras

- Available expander board features 24K static RAM (additional), dual mini-floppy interface, port adapter for printer and modem and an OSI 48 line expansion interface.
- Assembler/editor and extended machine code monitor available.

ORDER FORM

Order direct or from your local Ohio Scientific dealer.

- ☐ I'm interested. Send me information on your:
- ☐ Personal Computers ☐ Business Systems
- ☐ Send me a Superboard II \$279 enclosed
- ☐ Send me a Challenger 1P \$349 enclosed
- ☐ Include 4 more K of RAM (8K Total) \$69 more enclosed

Name

Address

City State Zip

Payment by: BAC (VISA) ☐ Master Charge ☐ Money Order ☐

Credit Card Account #

Expires Interbank # (Master Charge)
Ohio Residents add 4% Sales Tax

TOTAL CHARGED OR ENCLOSED

All orders shipped insured UPS unless otherwise requested. FOB Aurora, OH

Interested in a bigger system? Ohio Scientific offers 15 other models of microcomputer systems ranging from single board units to 74 million byte hard disk systems.

OHIO SCIENTIFIC
America's Largest Full Line Microcomputer Company
1333 S. Chillicothe Road • Aurora, Ohio 44202 (216) 562-3101

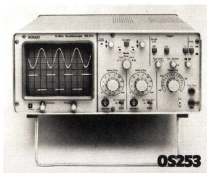
GOULD PROFESSIONAL OSCILLOSCOPES AT PRICES YOU CAN AFFORD.

Whatever your interest in electronics, you know that a quality oscilloscope with a broad range of features and functions can make your work a lot easier. Gould oscilloscopes are built to solve your problems and priced so you can afford the professional equipment you need right now. All are complete, ready for use, including passive probes, input leads and a comprehensive maintenance and operation manual.



OS245A

The OS245A is a compact, dual trace instrument with a 10MHz bandwidth and 5mV/div sensitivity. It has exceptional trigger performance and a full compliment of facilities for industrial, educational, and field service applications.



OS253

The OS253 is a 12MHz dual-channel scope with all the features of the OS245A plus a larger display area, more sensitivity and channel sum and difference.

The dual trace OS255 weighs only 15 lbs. yet offers features normally found in more expensive instruments such as flexible triggering facilities and 2mV/cm sensitivity across its full 15MHz bandwidth.



OS255

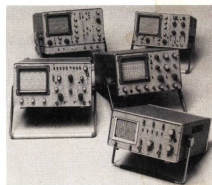
The dual beam OS260 gives true representation of two separate signals on the same time frame without beam chopping or alternating. Features include a high brightness CRT operating at 10kV

allowing a clear display of all waveforms.



OS260

For additional information on this exciting new line of sensibly priced, professional oscilloscopes or for sales locations in your area: call toll free (800) 325-6400 Ext. 77. In Missouri call (800) 342-6600.



Gould also manufactures an additional line of general purpose oscilloscopes for industrial, scientific and laboratory applications.

 **GOULD**

Radio-Electronics®

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS
Electronics publishers since 1908

FEBRUARY 1979 Vol. 50 No. 2

BUILD ONE OF THESE

- 37 **Pro Quality String Synthesizer**
Latest innovation in electronic music synthesizers is easy to build yet gives the soloist and small groups the background needed to enhance the performance.
- 42 **Solar Tracking System**
Electronic servo system swivels the solar collector panel so it follows the sun.
- 45 **Audio Test Station**
Part 2: Not an easy project. This all-in-one unit combines several important test instruments. Build it a section at a time.

GENERAL ELECTRONICS

- 4 **Looking Ahead**
Tomorrow's news today.
- 49 **Cases & Cabinets for Everyone**
Another installment of a roundup showing cases for projects and where you can get them.
- 53 **PC/Wire Wrap—New Construction Technique**
Combining wire-wrap with a printed circuit is the answer to many layout and construction problems. See how an expert does it.
- 68 **You Can Be A CET**
Another quiz to help you get ready to take the NESDA/ISCET CET test.

COMMUNICATIONS

- 63 **Troubleshooting Communications Receivers**
The right signal generator plus good diagnostic ability and precise bench techniques lead to rapid 2-way radio repairs.
- 65 **FM Detector and Filter Tests**
Proper operation of FM detectors is vital to reliable operation of 2-way radio gear. Here's how they work and how to keep them working.

STEREO HI-FI PRO SOUND

- 56 **New IHF Amplifier Specifications**
New testing standard makes amplifier comparisons more realistic for the layman. Provides a closer correlation between what he hears and what the lab technician measures.
- 59 **R.E.A.L. Audio Tests Yamaha CR-420 AM/FM Receiver**
Earns a "Very Good" for overall sound quality.
- 62 **R.E.A.L. Audio Tests SAE 4100 Time Delay System**
Rates an "Excellent" for overall sound quality.

MONTHLY FEATURES

- 74 **Hobby Corner**
Learn solid-state circuitry as you complete your monophonic music maker.
- 76 **Computer Corner**
8085—A look at two memory IC's that are among the 8085 family of devices.
- 80 **Jack Darr's Service Clinic**
Troubleshooting starter circuits in pulse-width modulated power supplies.
- 81 **Service Questions**
R-E's Service Editor solves technician problems.

EQUIPMENT REPORTS

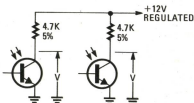
- 24 **A.P. Products Powerace 103 Breadboard & Power Supply**
- 26 **Simpson 462 Digital Multimeter**
- 32 **C.W. Moser 6502 Editor Assembler**
- 34 **Hustler MOT Monitor Antenna**

DEPARTMENTS

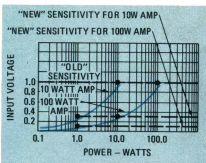
- | | |
|------------------------------|--------------------|
| 122 Advertising Index | 97 Market Center |
| 14 Advertising Sales Offices | 6 New & Timely |
| 92 Computer Products | 96 New Literature |
| 78 Communications Products | 86 New Products |
| 123 Free Information Card | 95 Next Month |
| 16 Letters | 94 Stereo Products |

ON THE COVER

It looks like an electronic organ, but it isn't. It is a string synthesizer. Plunk the keys and play a banjo, or guitar, or piano, or. . . Build one for yourself. Construction details start on page 37.



PHOTOTRANSISTOR SENSORS for the heart of this solar tracking device that follows the sun. Use it with your solar energy collection system. Complete details start on page 42.



NEW IHF SENSITIVITY RATING SPECIFIES THE INPUT VOLTAGE REQUIRED TO PRODUCE A 1-WATT OUTPUT. STORY STARTS ON PAGE 56.

Radio-Electronics, Published monthly by Gernsback Publications, Inc., 200 Park Avenue South, New York, NY 10003. Phone: 212-777-6400. Second-class postage paid at New York, NY and additional mailing offices. One-year subscription rate: U.S.A. and U.S. possessions, \$9.98, Canada, \$12.98. Other countries, \$14.98. Single copies \$1.25. © 1979 by Gernsback Publications, Inc. All rights reserved. Printed in U.S.A.

Subscription Service: Mail all subscription orders, changes, correspondence and Postmaster Notices of undelivered copies (Form 3579) to Radio-Electronics Subscription Service, Box 2520, Boulder, CO 80322.

A stamped self-addressed envelope must accompany all submitted manuscripts and/or artwork or photographs if their return is desired should they be rejected. We disclaim any responsibility for the loss or damage of manuscripts and/or artwork or photographs while in our possession or otherwise.

looking ahead

Videodisc mergers? Although many different noncompatible videodiscs have been demonstrated, as outlined previously ("Looking Ahead," **Videodisc boxscore**, November, 1978), the multiplicity of these systems may evaporate or dwindle as manufacturers face reality. The optical system, which basically was a compromise between similar Philips and MCA systems, is already being produced by Magnavox (videodisc players) and MCA Disco-Vision (videodisc records) in the United States. In Japan, the joint Japanese-American company, Universal Pioneer, plans to start player production this year.

So the optical system is the one manufacturers wish to stop, if they want to field simpler nonlaser players. Nonlaser systems have been demonstrated by RCA, Matsushita, JVC, Toshiba and Telefunken—the latter now being on limited sale in both Europe and Japan in a 10-minute-per-disc version. The RCA and JVC versions are capacitance systems. Matsushita and Telefunken are classified as mechanical systems. Except for RCA and Toshiba, which are compatible, the systems have little in common except that they're nonoptical. They all use grooved discs (except for JVC) and spin at 450, 900, or 1800 rpm. Even the center-hole diameters are different.

Although it's not official yet, there's strong evidence to suggest an effort will be made to bring all these systems into compatibility before commercializing them. The resulting system—if there *is* one—is expected to have some features of the optical version, such as being able to provide slow and fast motion but to be potentially less expensive in terms of players and perhaps discs. The result could be a sort of "stop-Philips" effort; in effect, optical vs. nonoptical systems. Although this situation isn't ideal, two "standards" are preferable to five or six.

New watch display: Electrochromic displays are claimed to be price-competitive with LCD's, but have some major advantages. The first company to announce the commercialization of this technique is Sharp, which says it will have a line of ECD's this spring.

Several companies have been working on ECD's for four or five years. These displays use metallic chemicals that change to a dark color when a voltage is applied. Once changed, they retain their color until the voltage is reversed—a power-saving feature. They have considerably higher visibility than LCD's, primarily because their image is nondirectional. They can be manufactured in any color, and the numerals stand out clearly against a contrasting background. The color of Sharp's initial displays will be blue. Electrochromic displays are relatively slow and, in their initial development, at least, it was felt they were not fast enough for calculators. Sharp hasn't stated whether its product will have a calculator display.

TV developments: A new single-gun color tube, scheduled to be sold this year in small-screen battery-powered sets manufactured by Matsushita, is claimed to have an extremely low power drain, making it

possible for a set to operate for three hours on nine flashlight batteries. Its color phosphors are separated by black control stripes that emit ultra-violet rays for beam indexing. If this sounds familiar to some color TV oldtimers, it bears a striking similarity to Philco's widely demonstrated (but never produced) "Apple" tube of the 1950's.

Photochromic glass has been used in windows and sunglasses, and now it may be adapted to black-and-white TV. The Corning Glass product darkens under strong light and lightens when ambient light is less intense. For outdoor viewing of a portable TV, the glass darkens enough to eliminate the need for a separate plastic sunshield. For indoor viewing, the glass lightens—providing proper contrast under all viewing conditions. Corning is now working on the development of a glass that darkens enough to provide these contrast-enhancing features.

"Picture-in-picture" TV is offered in Europe as a special feature that lets the viewer watch two channels simultaneously, the supplementary channel being superimposed in a corner or at the bottom of the large-screen color picture. The only trouble is, the secondary picture is in black-and-white. Now, Hitachi says it has changed all that and will be selling a two-picture color set in which *both* the main and the superimposed pictures are in color. A digital semiconductor memory makes it possible to provide the second-channel insert in color.

In-flight video: Video tape is about to take over for film in the airborne movie business. Bell & Howell has sold American, Continental and Laker Airlines on a new technique that uses a modified VHS 1/2-inch videocassette recorder and a projection TV system. Among the advantages of a VHS system is the size of the cassette, as contrasted with the large 16-mm movie reel used in film systems. And with film systems, the reels generally are changed by engineers on the ground. Flight attendants can easily flip a cassette in the VCR, which is mounted in a luggage rack. The projector uses three side-by-side 5-inch monochrome projection tubes, weighs 65 lbs. and is installed in the cabin ceiling. The picture is projected onto a standard 30- by 40-inch pull-down screen. Bell & Howell says it plans to introduce a home version of the projector this year for built-in and conventional installations. Its advantages over other home systems, as claimed by the manufacturer, are: it's bright enough to be able to use any flat movie screen, or even a light-colored wall, instead of a parabolic directional screen.

Another new Bell & Howell "why-didn't-they-think-of-it-before" system for the airlines is a wireless headphone for stereo music or movie sound. For the high-ceilinged new planes, Bell & Howell will also supply wireless attendant-call and light-switch systems.

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

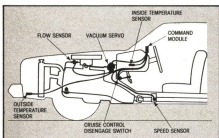
Automotive "brain" astounds the experts, puts both computer and cruise control at your fingertips!

For the first time ever, you can put a true computer in your car, truck or RV which gives you the most effective and functional cruise control ever designed, plus complete trip computing, fuel management system, and a remarkably accurate quartz crystal time system. It is called CompuCruise_{TM}.

So simple a child can operate, the new CompuCruise combines latest computer technology with state-of-the-art reliability in a package which will not likely be available on new cars for years to come.

CRUISE CONTROL WITH A MEMORY, UNIQUE SEEK-AND-HOLD CAPABILITY.

CompuCruise remarkable cruise control performs in a totally different manner than any other unit because it is more than a simple speed maintaining device. With CompuCruise, you establish your desired cruising speed even before you reach the highway and activate the system any time by simply pressing a button. CompuCruise then seeks and maintains the desired speed until you override or shut off the system. You resume cruise control again at any time by pressing the same button. CompuCruise, unlike most vacuum-mechanical systems, is fully electronic, more accurate and more reliable than any other unit you can buy.



AIRLINE PILOTS COMPARE COMPUCRUISE_{TM} TO SOPHISTICATED AVIONICS EQUIPMENT.

Similar to types of computers used on modern airliners, the CompuCruise slim panel-mounted control module contains a digital readout and back-lighted control buttons, both readily visible in the dark. By quickly learned systems of inquiry, the driver can elicit virtually any informa-



tion relating to time, distance, fuel and performance of his vehicle.

There are a number of digital-type instruments on the market which can be purchased for your car, purporting to provide functional data on performance, but all are basically calculators, operating on fixed information provided by the driver.

CompuCruise is a true computer, operating from automatic data sensors which constantly react to changing conditions, automatically recomputing vital data every second. Each function operates independently, with data displayed and updated constantly until you change your request of the computer.

Fuel management takes on new significance because CompuCruise tells you the most effective driving speeds, the type and brand of gasoline most suitable for your vehicle. It will tell you the effects of different types of tires and different tire pressures, road conditions, and engine tune-up condition. You can get instantaneous computations on current gas mileage, fuel required to arrival, and actual fuel remaining.

Battery condition can be checked regularly, saving you from the potential embarrassment of being stranded without warning.

TYPICAL DATA:

- ✓ Cruise Control
- ✓ Time, E.T., Lap Timer, Alarm
- ✓ Time, Distance, Fuel to Arrival
- ✓ Time, Distance, Fuel to Empty
- ✓ Time, Distance and Fuel on Trip
- ✓ Current or Average MPG, GPH
- ✓ Fuel Used, Distance since Fillup
- ✓ Current and Average Vehicle Speed
- ✓ Inside, Outside or Coolant Temperature
- ✓ Battery Voltage
- ✓ English or Metric Display

COMPUCRUISE_{TM} DIGITAL QUARTZ CRYSTAL TIME SYSTEM IS INCREDIBLE.

CompuCruise digital time system performs four independent time functions encompassing (a) stop watch and lap timer functions, (b) hours, minutes and seconds, (c) alarm or warning function, and (d) trip time indicator. The time system operates full time, whether your vehicle is operating or not. It will even wake you up after a short roadside nap.



YOUR COMPUCRUISE IS SMART! IF YOU PUSH THE WRONG BUTTON IT WILL LET YOU KNOW BY DISPLAYING "ERROR".

COMPUCRUISE_{TM} WORKS ON FOREIGN OR AMERICAN CARS; IS PRICED FOR THE AVERAGE MAN'S BUDGET

You do-it-yourselfers can readily install the unit, but complete and detailed instructions are also included for the automotive service facility. CompuCruise units are fully operable on most foreign or American cars, trucks or RV's. At \$199.95 the unit is only a few dollars more than the cost of cruise control alone on most vehicles, yet offers a whole new world of computerized management functions.

This is an exclusive system, fully warranted for 90 days from installation, delivered to you complete with all required hardware. You need only basic tools for the total job.

When you receive your unit, inspect it completely. If you are not 100% satisfied, return the complete unit before installation and your money will be refunded without question.

TO ORDER YOUR UNIT, complete the coupon below, enclosing \$199.95 (Add \$5.50 if front-wheel drive). This covers all shipping, insurance and handling costs. Your unit will be shipped within three weeks.

NOTE: Mountable on foreign or domestic vehicles including standard trans. EXCEPT FOR DIESEL OR FUEL INJECTED ENGINES.



(415) 935-4960

Technically competent personnel available to answer your questions.



CompuCruise

TO: ZEMCO, Inc. (415) 935-4960
1136 Saranap Avenue
Walnut Creek, CA 94595

Ship _____ CompuCruise_{TM} units @ \$199.95
Model 44 (WITH CRUISE CONTROL)
☐ Add \$5.50 for front-drive

Ship _____ CompuCruise_{TM} Units @ \$159.95
Model 41 (WITHOUT CRUISE CONTROL)
☐ Add \$5.50 for front-drive

Total enclosed: \$ _____
(CA residents add Sales Tax)

Charge to my ☐ Master Charge ☐ Visa

Card Number _____

Date Expires _____

Signature _____

Make vehicle: _____

Name: _____

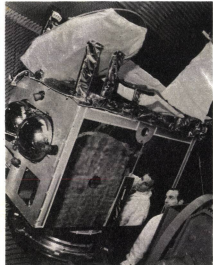
Address: _____

City: _____ State & Zip _____

Electronic music newsletter now available

A monthly newsletter, *Device*, is now available to those in the electronic music field. The publication covers such topics as new product reviews of musical equipment, construction articles, circuit-design features, etc.; it carries no advertising and is entirely subscription-supported. Yearly rates: \$15 (U.S.); \$16 (Canada/Mexico); \$18 (international). For information, write *Device*, P.O. Box C, Carmichael, CA 95608.

ANIK-B COMMUNICATIONS SATELLITE



ANIK-B, a domestic communications satellite, has been constructed by RCA Astro-Electronics for Telesat Canada. It is the first such satellite to operate in the dual frequency bands of 6- and 4-GHz and 14- and 12-GHz. A Telesat engineer is shown here performing antenna pattern measurements. The mirrors are part of the thermal system that keeps the spacecraft at cool operating temperatures.

Bell Labs scientists win 1978 Nobel Physics Prize

Bell Labs scientists Dr. Arno A. Penzias and Dr. Robert W. Wilson received the 1978 Nobel Prize in Physics jointly with Professor Piotr Kapitsa of the Moscow Academy of Sciences (Prof. Kapitsa received his award for his work in low-temperature physics).

Drs. Penzias and Wilson won their shared prize for their work in cosmic microwave background radiation. As early as 1964, when they were using a Bell Labs antenna to search for radio noise sources that were interfering with satellite communications, they discovered a faint pervasive radio signal that remained steady round the clock, season to season—an unusual

and unique phenomenon. After eliminating possible sources of the signal (such as the Milky Way, the sun, poorly fitted antenna joints, even nesting pigeons!), the conclusion became inescapable—the signal was the result of the radiation still remaining after the big bang that had created the universe approximately 2 billion years ago. Their conclusions were verified by Professor Robert H. Dicke of Princeton who had been conducting similar studies.

Although the "Big Bang" theory had been known to astro-physicists for a long time, up until Penzias and Wilson's discovery of the background radiation, the theory had never been satisfactorily verified. When the two physicists (along with Prof. Dicke and his co-workers independently) published their results, their discovery was finally understood to be a major breakthrough in understanding the origins of the universe.

Videocassette exchange service available

Owners of Beta and VHS 1/2-inch format VCR's can avail themselves of the services provided by the Video Cassette Exchange Division of Discotronics Inc., New Jersey, in which customers can either buy or exchange videocassettes at greatly reduced rates.

The 1979 catalog lists approximately 600 prerecorded film titles, some of which have never been seen on TV. The company also offers trade-in privileges that are similar to those of a rental library. And, for convenience, they also provide a nationwide home pickup service for a small charge. For more information, contact Robert Edwards, Discotronics Inc., 50 North Main Street, Cranbury, NJ 08512.

New communication service proposed by radio amateur group

In 1977 amateur radio operators of WA2RPG (Center for Advanced Study in Education, Graduate School of CUNY, New York City) filed a petition with W2KQP, requesting the implementation of a community service that would use the communicating concept to broadcast messages on UHF channels.

Communicating uses a low-power community-based repeater station that can transmit audio and video signals up to a 30-mile radius, using a high antenna. The repeater station receives signals from different areas of the community and then transmits them via any unused UHF TV channel. The petitioning group additionally requested that low-power facilities be exempt from the usual rigid broadcast standards in an effort to keep costs down.

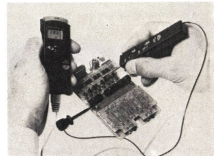
Praising the communicating concept, the FCC has stated that: "The petition and comments by others suggest an imagina-

tive and potentially beneficial public service television concept . . . an activity that deserves considerable attention in the overall inquiry."

Swiss watch firm designs microminiature DMM

Heuer Time & Electronics, Inc., watch and timepiece manufacturer, has taken the plunge into the world of microelectronic instrumentation by designing what it calls "the world's smallest digital multimeter," using the company's experience in microminiaturizing watches.

The model DM 2000 meter (displayed for the first time at Newcom '78, Las Vegas) weighs less than 3 oz., including probe and



MICROMINIATURE DIGITAL MULTIMETER provides multiple ranges, modern microminiaturization techniques, remote-control probe, LCD readout and high reliability. The instrument weighs less than 3 oz., including probes and batteries.

batteries, and (minus probe) measures only $4 \times 0.78 \times 0.47$ inches. In addition to its four measurement range capability—to 1000 DC, 700 VAC, AC/DC current to 2 amperes, and resistance to 20 megohms—two major technical features lie in its true AC RMS measurement and complete RF shielding. It also provides up to 100-hour battery life, an error-free LCD display (due to its remote-control probe), plus great reliability for field-service applications where accuracy and portability can be vital.

The model DM 2000 is expected to sell for \$450. For further information, write Hans J. Kueffer, Heuer Time & Electronics, 960 South Springfield Avenue, Springfield, NJ 07081.

Newsflash!

As we're about to go to press, we've received word that Texas Instruments has received type-approval from the FCC on a computer that connects to the antenna terminals of a TV receiver. Could it be that Texas Instruments will be entering the home computer market? Formal introduction of this new device is scheduled to take place at the Consumer Electronics Show,

continued on page 12

new design... new features...unique, time-tested principle!

Weller® controlled output soldering station

Model WTCPN. New convenience-features. Striking contemporary appearance. Completely new design. Now more than ever in a class by itself. Only Weller's advanced engineering could have improved on its own predecessor WTCPL Station, popular standard of the electronics industry.

- new heat shield for cool operator comfort
- new plug-in iron design for zero down-time
- new integral tip-storage tray
- new larger sponge for easier tip cleaning
- improved, unitized rocker switch and neon indicator light
- new impact-resistant case

And add to these new features Weller's unique, proven, closed-loop, low-voltage circuit, with its "interchangeable brains" in the tip... a ferromagnetic sensor that controls the temperature at 600, 700, or 800°F., protecting sensitive workpieces. To change temperatures, simply change tips with knurled thumbscrew. More than 50 options in configuration, tip size, reach, and temperature! Exclusive-process triple-plating prevents tip oxidation and "freezing".

With all these new features and exclusive principles, Model WTCPN is still all function... no frills! It's UL-listed and OSHA-compliant, of course. And now it's available at leading electronic distributors... coast-to-coast. See it there. For technical information, write on your letterhead.



The Cooper Group
Electronics Division

WELLER® • WISS® • XCELITE®

P.O. BOX 728, APEX, NORTH CAROLINA 27502, 919/362-7511

CIRCLE 41 ON FREE INFORMATION CARD

Everybody's making money selling microcomputers. Somebody's going to make money servicing them.

**New NRI Home Study Course Shows You How to Make Money Servicing, Repairing,
and Programming Personal and Small Business Computers**



Seems like every time you turn around, somebody comes along with a new computer for home or business use. And what's made it all possible is the amazing microprocessor, the tiny little chip that's a computer in itself.

Using this new technology, the industry is offering compact, affordable computers that will handle things like payrolls, billing, inventory, and other jobs for businesses of every size...perform household functions including budgeting, environmental systems control, indexing recipes, and more. And thousands of hobbyists are already owners, experimenting and developing their own programs.

Growing Demand for Computer Technicians

This is only one of the growth factors influencing the increasing opportunities for qualified computer technicians. The U.S. Department of Labor projects over a 100% increase in job openings for the decade through 1985. Most of them *new* jobs created by the expanding world of the computer.

Learn at Home in Your Spare Time

NRI can train you for this exciting, rewarding field. Train you at home to service not only microcomputers, but their larger brothers, too. Train you at your convenience, with clearly written "bite-size" lessons that you do evenings or weekends, without going to classes or quitting your present job.

Assemble Your Own Microcomputer

NRI training goes far beyond theory. It includes practical experience, too. As you progress, you perform meaningful experiments building and studying electronic circuits on the NRI Discovery Lab[®]. You assemble test instruments that include a transistorized volt-ohm meter and a CMOS digital frequency counter...instruments you learn on, use later in your work.



And you build your own microcomputer. Each step of construction advances your knowledge, gives you deeper insights into this amazing world that's upon us.

This is the only microcomputer designed for learning. It looks, operates, and performs just like the finest of its kind...actually does more than many commercial units. But NRI engineers have designed components and planned the assembly procedure so it demonstrates important principles, gives you working experience in detecting and correcting problems.

And that's what NRI training is all about.



Other Opportunities in Electronics

Since 1914, before commercial radio was even on the air, NRI has been the way to learn new electronics skills. Today's modern offerings include, in addition to three different computer courses, TV/Audio/Video Systems Servicing, with training on the only designed-for-learning 25" diagonal color TV, with state-of-the-art computer programming. Or, check out our Complete Communications Course, preparing you to enter this booming field servicing, installing, and repairing equipment like microwave, broadcast, CB, shortwave radio, paging, radar, and more.

Mail Postage-Paid Card for Free Catalog No Salesman Will Call

Send today for your free copy of our 100-page, full-color catalog. It describes all of our electronics courses in detail, showing kits, equipment, and lesson plans. Look it over at your convenience, then decide how NRI can help you make the most of your talents. There's no obligation and no salesman will ever call or bother you. With more than a million students and unmatched experience in home training, NRI gives you the most in training for new opportunity! If card has been removed, write to:



NRI Schools
McGraw-Hill Continuing
Education Center
3939 Wisconsin Avenue
Washington, D.C. 20016

new & timely

continued from page 6

which will be held in Las Vegas on January 6-9.

We have also learned that Atari is preparing to introduce a BASIC interpreter for their programmable video game. This will also be introduced at CES.

Admiral TV production is discontinued

Rockwell International Corporation recently announced that it would discontinue all its Admiral TV products. Admiral marketing activities are currently being phased out, and, once current commitments are fulfilled, all production will cease at the Harvard, IL, and Taiwan plants.

Charles Fazio, president of Rockwell's consumer operations, has emphasized that the company would continue to provide warranties, service and spare parts support; and added that the phasing out of its TV production would enable Rockwell to concentrate its efforts on its ongoing appliance business and other operations.

The reason given for discontinuing the Admiral TV line was "intense price competition, particularly from Japanese sources," which the company felt did not justify any additional outlay of its resources.

Two-layer solar cell provides 28% conversion to electricity

Varian Associates, Inc., of Palo Alto (under contract to the Department of Energy's Scandia Labs) has developed a prototype solar cell system that converts 28.5% of the sun's rays to electricity.

The Varian system uses two different cells—an aluminum gallium arsenide (AlGaAs) cell and a silicon cell—to perform the conversion. A special filter between the cells separates solar radiation into long and short wavelengths; it permits the longer rays to penetrate the silicon cell, while allowing the shorter rays to pass through into the AlGaAs cell. This effect is achieved by using a concave mirror to focus the solar energy onto the filter. The AlGaAs cell converts 17.4% of the rays to electricity, while the silicon cell converts 11.1% of the rays.

Sandia Labs supervisor Dr. Donald G. Schuele predicts that by 1986, photovoltaic systems "will produce electricity for \$1 per-peak-watt of installed capacity, or from 6¢ to 8¢ per kilowatt-hour."

Sprague and Johnson receive EIA awards

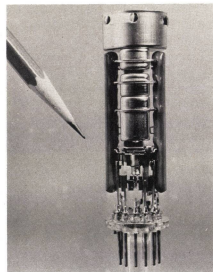
During its fall 1978 conference, the Electronic Industries Association voted to award the EIA Medal of Honor to Robert C. Sprague, Sr., for his devotion and long years of service to the Association and the electronic industry. Among Mr. Sprague's most recent accomplishments are his efforts to revise the Custom Penalty Laws to

remove unfair penalty provisions for the industry. Active for many years in EIA, he was a member of the Board of Governors since 1943 and board chairman from 1950-1954. This is the second time Mr. Sprague has won the EIA Medal of Honor, the first having been 25 years ago. The presentation will be made at EIA's spring 1979 meeting.

At the same conference, Raymond E. Johnson, EIA general counsel, received the EIA Distinguished Service Award, the first staff member to be so honored. Mr. Johnson has served as EIA general counsel since 1970 and was elected corporate secretary in 1972. He received his award for his years of distinguished service to EIA and his involvement in the Association on all levels.

RCA electron gun sharpens color TV pictures

RCA Laboratories and the technical staff of the RCA Picture Tube Division have developed a device that is used to create sharper color television pictures. This latest



IMPROVED ELECTRON GUN developed by RCA Picture Tube Division can be used in all sizes of color TV tubes to create sharper pictures.

development is a new kind of electron gun that "shoots" invisible beams at color phosphors on the picture tube face. The result is improved focus and, thus, sharper pictures. The gun, which is now in commercial production, can be used on any size picture tube.

The results of this joint effort were presented in a paper delivered at the annual Chicago Fall Conference on Consumer Electronics by Picture Tube Division engineers Richard H. Hughes and Jim Y. Chen.

Metal-tape standards surveyed at ITA meeting

Representatives of companies manufacturing record and playback equipment, audio tape, duplicating equipment and ferric oxide attended a late 1978 meeting of the Audio Technical Executive Committee of the International Tape Association (ITA), to discuss industry-wide standardization of metal audio cassette tape.

However, because record/playback and erase heads are still not standardized, the committee could not come to any firm decision about standards for metal tape. Several companies, however, stated their readiness to enter the metal-tape market.

Among these were 3M Company, which already introduced their metal-particle *Metafine* tape, and Sharp Electronics with its prototype metal-tape recorder. Panasonic is presently developing metal-tape cassette decks and a duplicator for 1/2-inch VHS videocassettes. Fuji and 3M together are working on high-energy contact duplication of metal-particle videotape. BASF plans to introduce its metal-tape product at the 1979 Berlin Fair. Other companies continuing their R & D activities are Ampex, Maxell, Sony and TDK. Oxide supplier Hercules, Inc., said it would be producing metal-tape particles in quantity by 1979.

FCC asks, should TV sets be graded?

The Federal Communications Commission has started an inquiry to determine whether it should set up a system for grading TV receivers, since it feels that customers do not presently have enough information to help them select the best TV's and antennas for their needs. Here are some of the questions the FCC is asking:

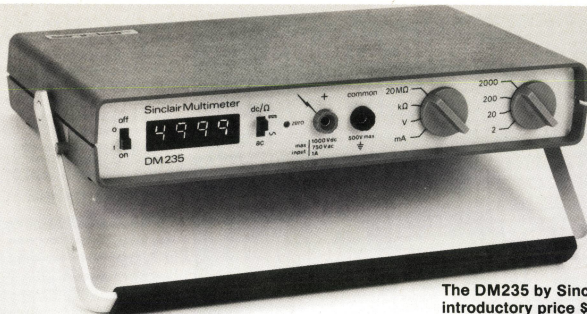
1. If the consumer wants more information on TV systems, what kinds of data should be made available, how should it be presented and would it really improve one's ability to select a set? Should the equipment have a permanent label affixed? Should there be a brochure enclosed with each set? A letter-grading system, or a descriptive grade system (i.e., "excellent," "good," etc.)?

2. Some TV sets experience "snow" on the picture screen that is the result of noise. Should TV receivers show the maximum noise value for that set? How should this be presented to the public?

3. Should each purchased set contain more installation and operating instructions than are presently provided?

Deadline for filing comments with the FCC is February 1, 1979. The docket number is Gen. Doc. 78-307, and for a copy of the notice, write Consumer Assistance Office, Federal Communications Commission, Washington, DC 20554.

R-E



The DM235 by Sinclair
introductory price \$89.95.

Full Performance, "Portable/Benchtop" Digital Multimeter!

Sinclair's new DM235. The best digital meter value in the world at \$89.95!

The Sinclair DM235 provides full facilities for every application, including field servicing, testing and laboratory work, at a price no other digital multimeter can approach.

High accuracy, resolution and input impedance are combined with a large, wide-angle LED display to provide quick, clear, unambiguous readings wherever you use it.

Automatic polarity selection, simple clear controls and the use of a single input terminal pair for all functions, provide for maximum convenience in operation.

The DM235 measures DC Ω and AC Ω volts, DC Ω and AC Ω current, and resistance in a total of 21 ranges (with an additional 5 decade test ranges), giving it the versatility to tackle any job.

The display is a full 3½ digits reading to ± 1999 . Large, high brightness 8mm LEDs give clear, unambiguous readings with an ultra wide angle of view. And an LED display means proven life-time reliability.

The Sinclair DM235 is fully portable and has complete independence of AC line via operation from four C-size (R14) cells. Alternatively, where continuous operation on the bench is required, an optional AC adaptor/charger is available. To increase flexibility still further, a rechargeable battery pack and an ever-ready carrying case with neck strap are also available as options, as is a 30kV probe.

A sensible new concept in meter design for use on the bench or in the field!

Up till now, choosing a meter suitable for use on the bench and in the field hasn't been easy. Either you bought a bulky, bench instrument that was awkward to carry around, or a hand-held portable that was difficult to use on the bench. The Sinclair concept is different — by keeping the thickness down to only a fraction over 1½" (40mm) and the weight down to under 1½lbs (650gms), we've produced an instrument that has all the advantages of conventional bench meters, but packs neatly into any tool kit or brief case.

- Fully protected • Accuracy is quoted as a percentage of reading • Resistance ranges provide a diode test facility at 5 decade steps of current • Automatic overrange indication by horizontal bars • Automatic decimal point placement • Facility for battery condition test
- Reading rate 2½ per second • Temperature coefficient $< 0.05/\circ 1$ of applicable accuracy specification • Dimensions 10" x 5.8" x 1.6" (255 x 148 x 40mm) • Weight less than 1½ lbs (640gms)

Features you'd expect to pay \$200 or more for:

- Lightweight, but extremely rugged cyclocase (stackable) • Large, bright, wide angle LED display reading to ± 1999 • Automatic polarity selection • Industry standard 10M Ω input impedance 0.5% of reading basic accuracy • Full multimeter facilities including AC Ω current • Resistance measurement up to 20M Ω • Direct reading of semi-conductor forward voltages at 5 different currents • Simple, unambiguous controls with readings always in volts, mA or K Ω • Selection of all functions from a single input terminal pair • Automatic decimal point placement • Automatic overrange indication • Operation from disposable or rechargeable cells, or from AC adaptor/charger • 1 year over-the-counter service policy • 3½ digit resolution

The Sinclair DM235 at \$89.95 has all the features you'll most likely ever need. There is no reason to pay more, whether your application is to outfit a team of engineers, or for the hobbyist. It is fully protected, amazingly rugged (drop it without damage), lightweight, stackable... the advantages go on and on. And with Sinclair's innovative "Portable Benchtop" design, the DM235 is truly the only meter you'll ever need whether you are in the shop, on the road, or at work in the field.

A background of experience

It is part of a new range of instrumentation based on 'state-of-the-art' circuit design and complements an impressive record of electronic world firsts — from programmable pocket calculators to miniature T.V.s — where Sinclair has held a world lead through innovative electronics.

Supplied Complete with test leads and prods, and operator's instruction manual

Try the Sinclair DM235 for 2 weeks — No obligation.

Call toll free: 1-800-235-6945.
Calif. res. call: 805-966-7187.

Or send coupon:

Starshine Group.

924 Anacapa St., Dept. 636, Santa Barbara, CA 93101

Please promptly ship — Sinclair DM235 Digital Multimeter(s) @ \$89.95 ea. (plus \$3.95 shipping and insurance). If not completely satisfied I can return it within 2 weeks of receipt for a courteous, quick refund.

- ☐ Also send the following optional accessories:
- ☐ AC adaptor/charger @ \$89.95 ea.
 - ☐ Rechargeable battery pack @ \$39.95 ea. (Must be used with AC adaptor/charger).
 - ☐ Heavy duty carrying case @ \$29.95 ea.
 - ☐ 30kV High voltage probe @ \$29.95 ea.
 - ☐ Check or money order enclosed (CA res. add 6% sales tax).
 - ☐ Charge my credit card number below.
 - ☐ BankAmericard/Visa ☐ Master Charge (interbank no. _____)
 - ☐ Diners Club ☐ Carte Blanche ☐ American Express

Credit Card No. _____ Exp. Date _____

Name _____

Address _____

City/State/Zip _____

Signature _____



letters

THE TERM "BAUD" EXPLAINED

The article entitled "Digital Data Transmission—How A Computer Communicates" (May 1978 issue) provides a highly readable introduction to the subject that many novice computer enthusiasts will find

00 01 10 11 10 10 01 00



enlightening. However, the author commits a "technical foul" in making the unqualified statement that the term "baud" is used interchangeably with the term "bits-per-second."

The term baud means the number of times-per-second the line condition changes. If the line condition represents

the presence or absence of a *single* bit (as in two-state signaling), then the signaling speed in bauds is the same as bits-per-second. If, however, the signaling is not two-state, then bauds are *not* equal to bits-per-second. The latter condition exists, for instance, in "di-bit" or four-state signaling (see diagram), in which the baud rate is equivalent to the number of bits-per-second times two.

This explanation is an adaptation from *Introduction to Teleprocessing* by James Martin, a reference I recommend for those interested in further exploring the subject of digital data transmission.

MARVINO A. HILL
Los Angeles, CA

THE FUTURE OF ELECTRONICS

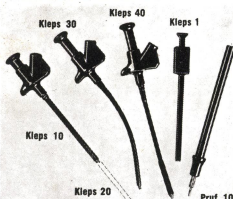
This is in answer to your September 1978 editorial in which you invited readers to send in their look at the future of electronics. Your No. 4 idea is not at all far out. At the very least, should gravity prove to be

meta- or parapsychical, control of the successful anti-gravity device will almost certainly be electronic in nature.

Electronics touches all fields of activity, even if remotely. Thus, all one has to do is just settle back and enter the light-trance state to foresee some very likely developments in coming decades. Whatever they may be, electronics will play a major part in their initiation, development, production, use and, yes, even in their eventual obsolescence. Here are my "predictions":

Transportation: In but half a century we have seen a transition from the horse to 500-passenger aircraft; the motor car has changed our life so drastically that should we run out of fuel our society as we know it would die like the dinosaurs; and the locomotive has been relegated to hauling freight. And still the insatiable appetite for travel expands.

One mode of transportation will revolutionize public, private and personal transportation. *continued on page 23*



Clever Kleps

Test probes designed by your needs—Push to seize, push to release (all Kleps spring loaded).

Kleps 10. Bathhook clamp grips wires, lugs, terminals. Accepts banana plug or bare wire lead. 4 3/4" long. **\$1.59**

Kleps 20. Same, but 7" long. **\$1.69**

Kleps 30. Completely flexible. Forked-tongue gripper. Accepts banana plug or bare lead. 6" long. **\$1.59**

Kleps 40. Completely flexible. 3-segment automatic collet firmly grips wire ends, PC-board terminals, connector pins. Accepts banana plug or plain wire. 6 1/4" long. **\$2.89**

Kleps 1. Economy Kleps for light line work (not lab quality). Meshing claws. 4 1/2" long. **\$1.29**

Prof 10. Versatile test prod. Solder connection. Molded phenolic. Doubles as scribing tool. "Bunch" pin fits banana jack. Phone tip. 5 1/2" long. **\$.99**

All in red or black - specify. (Add 50¢ postage and handling).

Write for complete catalog of - test probes, plugs, sockets, connectors, earphones, headsets, miniature components.

Available through your local distributor, or write to:

RYE INDUSTRIES INC.

127 Spencer Place, Mamaroneck, N.Y. 10543

In Canada: Rye Industries (Canada) Ltd.

CIRCLE 22 ON FREE INFORMATION CARD



Where's the screwdriver?



In a tool box, tools and parts are everywhere. They're hard to find. They get lost. (And they get dirty.)

With a Platt tool case, that wouldn't happen. It's designed so you'll know where everything is. Smaller tools are in individual pockets in our patented one-piece pallet. Larger tools and parts are in compartments. And papers and order book are in lid pockets. (Everything is neat and clean.)

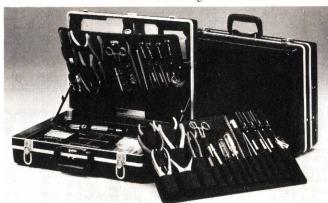
And Platt's tool case helps you look more professional. It comes in handsome, lightweight, durable ABS Thermoplastic. Or rich looking vinyl reinforced by ABS Thermoplastic.

What's more, it also has a 5 year guarantee. Contact us for complete information on Platt's full line of tool cases and your nearest distributor.

Pat. No. 3,880,285

Cases for business and industry.

2301 S. Prairie Ave., Chicago, Ill. 60616 (312) 225-6670



CIRCLE 51 ON FREE INFORMATION CARD

LX303

ALL THE MOST WANTED FEATURES AT A MOST WANTED PRICE...

1 1/2" HIGH LCD DISPLAY
USE INDOORS OR OUT
100 HOUR 9V BATTERY LIFE
AUTO ZERO, POLARITY,
OVERRANGE INDICATION
100 mV DC F.S. SENSITIVITY
9 RANGES AND FUNCTIONS

\$74.95

HICKOK



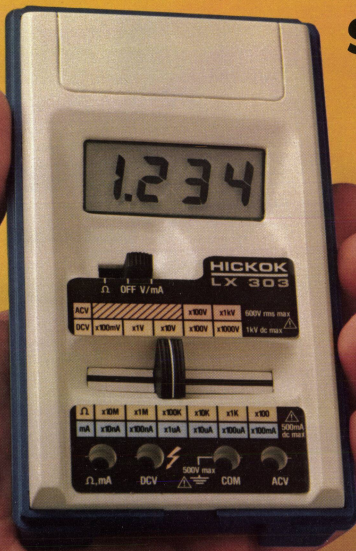
Removable cover stores test lead set furnished as part of the unit.



Available accessories include AC adapter, padded vinyl carrying case, 10KV DC probe, 10 Amp DC shunt.



10KV DC probe adapter available for protecting input up to 10KV.



Here is the handfull of accuracy you've been waiting for. Hand-somely encased.

Compact. Efficient. Only 8 ounces.

Hickok's exciting, new LX 303, 3 1/2 digit Mini-Multimeter with high quality components, one year guarantee and rugged Cycolac® case offers features previously found only in expensive units... at a price under \$75.00!

So why wait any longer? The amazing LX 303 is here, NOW! Another American made test equipment breakthrough from Hickok, The Value Innovator. Order today!

See your local Hickok distributor or order below

SPECIFICATIONS:

DC VOLTS (5 RANGES): 0.1mV to 1000V; Accuracy: $\pm 0.5\%$ rdg $\pm 0.5\%$ f.s.; Input imped: 10M Ω ; Max. input 1kV except 500V on 200mV range.

AC VOLTS (40Hz to 5kHz): 0.1V to 600V; Accuracy: $\pm 1.0\%$ rdg $\pm 0.5\%$ f.s. (-2 dB max. at 5kHz); Max. input: 600V.

RESISTANCE (6 LOW POWER RANGES): 0.1 Ω to 20M Ω ; Accuracy: $\pm 0.5\%$ rdg $\pm 0.5\%$ f.s. ($\pm 1.5\%$ rdg on 20M Ω range); input protected to 120VAC all ranges.

DC CURRENT (6 RANGES): 0.1nA to 100mA; Accuracy: $\pm 1.0\%$ rdg $\pm 0.5\%$ f.s.
DIMENSIONS AND WEIGHT: 5-7/8" x 3-3/8" x 1-3/4", 8 oz.; **POWER:** 9V battery (not included) or Hickok AC adapter; **READ RATE:** 3/sec.

ADVANCE ELECTRONICS

TO ORDER CALL TOLL FREE
800-223-0474

54 West 45th Street, New York, NY 10036 212-687-2224

PLEASE SEND ME

- ☐ Hickok LX303 Digital Multimeters @ 74.95 ea.
- ☐ RC-3 AC Adapter, 115VAC (220VAC avail.) @ 7.50 ea.
- ☐ CC-3 Deluxe Carrying Case @ 7.50 ea.
- ☐ VP-10 X10 DCV Probe Adapter @ 14.95 ea.
- ☐ CS-1 10A DC Current Shunt @ 14.95 ea.
- ☐ VP-40 40 KV DC Probe @ 35.00 ea.

Payment enc. ☐ Bill my: Master Charge ☐ VISA ☐

Account # _____ Exp. Date _____

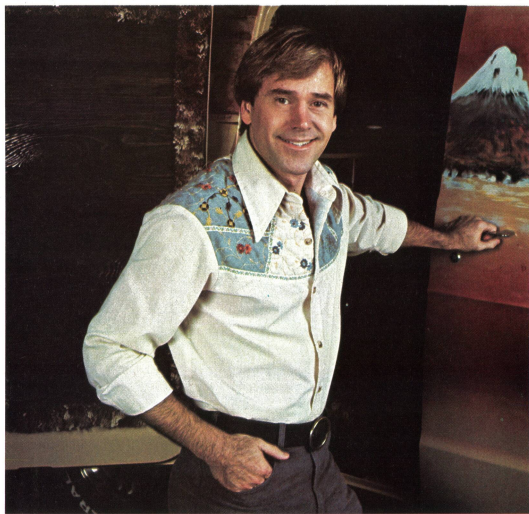
Name _____

Address _____

City _____ State _____ Zip _____

Add \$3.00 Postage and Handling, NY residents add sales tax.

You gotta shop around.



**When you do, you'll probably pick CIE.
You can't afford to settle for
less when it comes to something like
electronics training that could
affect your whole life.**

When you shop around for tires, you look for a bargain. After all, if it's the same brand, better price—why not save money?

Education's different. There's no such thing as "same brand." No two schools are alike. And, once you've made your choice, the training you get stays with you for the rest of your life.

So, shop around for your training. Not for the bargain. For the best. Thorough, professional training to help give you pride and confidence.

* * *

If you talked to some of our graduates, chances are you'd find a lot of them shopped around for their training. They pretty much knew what was available. And they picked CIE as number one.

Why you should shop around yourself.

We hope you'll shop around. Because, frankly, CIE isn't for everyone.

There are other options for the hobbyist. If you're the ambitious type—with serious career goals in electronics—take a close look at what we've planned for you at CIE.

What you should look for first.

Part of what makes electronics so interesting is it's based on scientific discoveries—on ideas! So the first thing to look for is a program that starts with ideas and builds on them!

That's what happens with CIE's Auto-Programmed® Lessons. Each lesson takes one or two principles and helps you master them—before you start using them!

How practical is the training?

This is the next big important question. After all, your career will be built on what you can do—and on how well you do it.

Here are ways some of CIE's troubleshooting programs help you get your "hands-on" training...

With CIE's Experimental Electronics Laboratory...

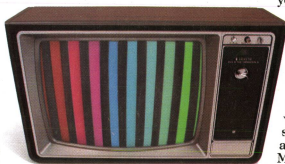


you learn and review the basics—perform dozens of experiments. Plus, you use a 3-in-1 precision Multimeter to learn testing, checking, analyzing!



When you build your own 5 MHz Triggered-Sweep, Solid-State Oscilloscope you take your first real professional step. You use it as a doctor uses an X-ray machine—to "read" waveform patterns... lock them in... study, understand and interpret them!

When you get your Zenith 19-inch Diagonal Solid-State Color TV you



Pattern simulated.

apply your new skills to some real on-the-job-type troubleshooting! You learn to trace signal flow... locate malfunctions... restore perfect operating standards—just as with any sophisticated electronics equipment!



When you work with a completely Solid-State Color Bar Generator—actually a TV signal transmitter—you study up to ten different patterns on your TV screen... explore digital logic circuits... observe the action of a crystal-controlled oscillator!

Of course, CIE offers a more advanced training program, too. But the main point is

simply this:

All this training takes effort. But you'll enjoy it. And it's a real plus for a troubleshooting career!

Do you prepare for your FCC License?

Avoid regrets later. Check this out before you enroll in any program.

For some troubleshooting jobs, you must have your FCC License. For others, employers often consider it a mark in your favor. Either way, it's government-certified proof of specific knowledge and skills!

More than half of CIE's courses prepare you for the government-administered FCC License exam. In continuing surveys, nearly 4 out of 5 CIE graduates who take the exam get their Licenses!

Shop around... but send for CIE's free school catalog first!

Mail the card. If it's gone, cut out and mail the coupon. If you prefer to write, mention the name and date of this magazine. We'll send you a copy of CIE's FREE school catalog—plus a complete package of independent home study information! For your convenience, we'll try to have a representative contact you to answer your questions. Mail the card or coupon—or write: CIE, 1776 East 17th St., Cleveland, OH 44114.

CIE Cleveland Institute of Electronics, Inc.

1776 East 17th Street, Cleveland, Ohio 44114
Accredited Member National Home Study Council

☐ **YES...** I'm shopping around for the **right** kind of career training in electronics troubleshooting—and CIE sounds well worth looking into. Please send me my FREE CIE school catalog—including details about troubleshooting courses—plus my FREE package of home study information! RE-57

Print Name _____

Address _____ Apt. _____

City _____

State _____ Zip _____

Age _____ Phone _____ (area code)

Check box for G.I. Bill information:
☐ Veteran ☐ Active Duty

Mail today!

Completely pre-assembled and pre-tuned

Just take it out of the package, and install it on the car. No tuning necessary... check it out with a watt meter and see for yourself!

Super-good looking low silhouette design. Your choice of cup colors design-coordinated to late-model cars.

SIERRA BRONZE



DIAMOND-FIRE BLACK



ATLANTIS BLUE



FIREHORN RED



SNOWCAP WHITE



CLASSIC SILVER AS SHOWN

AND CRYSTAL CLEAR

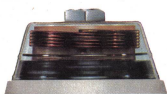
60" Stainless steel tapered whip... and NO spring

There's a Coil-in-the-cup

Magnet Mount

These new **Persuader™ Antennas** low profile, extra long whip deliver performance equal to, or better than anything else on the road!

There's a hand-wound, hand-tuned coil in the cup...



a major advance in antenna technology from the Antenna Pros field tested and field proven by thousands of CBers

Only \$34.98 suggested retail. Compare with K-40 at \$38.50 or any other antenna. You'll see there's no comparison.

5 year guarantee

Materials and workmanship of PERSUADER ANTENNAS (Models 13505 & 17605) are guaranteed for a full five years if this antenna is installed by the dealer and a full three years if this antenna is installed by the consumer.

Any part that fails within the guarantee period will be replaced absolutely free provided the registration card has been completely filled out and returned to Antenna Incorporated.



A word from the Old Pro:

When you buy this antenna, my reputation... built over 38 years in the antenna business... will be riding on your roof. I'm confident that the Persuader Antennas will persuade you... you've chosen the Best.

M.R. Friedberg, President
Antenna Incorporated

In stock at your dealer now...

or call the Antenna Hotline... 1-800-447-4700.

(Illinois: 800-332-4400: Sorry, no Hotline service in Alaska or Hawaii).



Charge to Visa or Master Charge... and we'll have your nearest dealer ship your Persuader Antenna promptly, in the mount and color of your choice. Hotline orders add \$1.50 for shipping and handling. Applicable local taxes extra. Allow 2 to 4 weeks for delivery.

The family of fine antennas from the fine antenna family.



26301 Richmond Road, Cleveland, Ohio 44146 (216) 464-7075

In Canada: Cardon Import Canada Ltd., P.O. Box 937 Hamilton, Ontario L8N 3P9
Antenna Incorporated, International Division, P.O. Box 1002 Rockville Centre, New York 11571

CIRCLE 63 ON FREE INFORMATION CARD

These features will persuade you... The Persuader™ Antenna is Your Best Antenna Choice

60" Stainless Steel Tapered Whip...and No Spring

The super-long whip increases the aperture of the antenna. This increases

- the signal capture area on reception
- the transmit signal and radiation intensity at the horizon
- bandwidth to well over a 40-channel capability

The .125" diameter whip is tapered, so shock is distributed evenly. There's no spring to stretch, break, or bend the whip away from the straightest possible upright position.

Exclusive coil-in-cup design

Loading of most low-profile antennas is by a simple printed circuit board that can't be tuned and will eventually burn out. These new Persuader antennas are completely pre-assembled and pre-tuned and feature an actual hand-wound, hand-tuned copper wire loading coil tested with 500 watts, rated at 100 watts continuous. It's even more efficient than our base-loaded coils because it's wound to a larger diameter, with fewer turns.

This unique design also involves fewer mechanical and electrical connectors—a fewer resistive contacts between loading coil and cable terminations—less chance for dust, moisture or road gunk to contaminate the contacts.

This concept has been field tested by thousands of CBers in our Model 13503 (shorter whip, plain white cup). Your good buddies will tell you everything we say about it is true.

Available with Trunk-Lip or Magnet Mount

for performance:

- SWR of 1.5:1 or less across all 40 AM and SSB channels.
- Shunt-fed loading coil is DC grounded for quiet performance; bleeds off static from rain, snow, air particles. Performance is virtually identical to body mount antennas.
- Center-roof placement of magnet mount provides your most uniformly omni-directional signal. (Also can mount on trunk lid).
- Unique Antenna Incorporated design provides capacitive coupling. Aluminum plate puts the ground potential right at the mounting surface.

for convenience: Magnet and trunk lip, the two easiest installations! Place the antenna where you want it, plug the cable into the transceiver. No holes to drill. Readily removed for anti-theft protection. Magnet mount supplied with 12' RG-58/U coaxial cable with PL-259 type connector; trunk lip mount with 17' of cable.

for magnet mount adherence: Heavy-duty 2½" magnet in plastic cup with soft rubber gasket. Holds at top highway speeds of 55 mph. (Trunk lip mount recommended for vinyl roof cars.) Since it won't walk, it won't detune! "Oil-can" effect of cup; resting on gasket, provides a larger magnet plane than if the magnet itself were touching the surface—yet there's less weight on the car, less scratch potential.

All magnet mount benefits
are standard...
not an extra-cost accessory!

LETTERS

continued from page 16

portation: The Transmatter! It is inconceivable that electronics will not play a major role in bringing the matter transceiver out of the sixth dimension and into the fifth, perhaps by the year 2000.

The workhorse locomotive will continue to be the major transport for heavy goods. Two excellent substitutes besides anti-grav for the rails: freight transmitters and automated factories that will manufacture any product (including foodstuffs) locally upon demand. An automated factory that might use hydrogen from water as its raw material would certainly use electronics in 100 interconnected ways.

Entertainment: Stage plays have given way to movies, and movies in turn have been taken over by TV. The same play that was artfully done for 1978 airwaves, can carry its message via satellite simultaneously to easily a hundred million, or even a couple of billion viewers.

The future patron of the arts must be so enraptured by sight, sound, smell, etc., that he *becomes* the protagonist. While we might anticipate that we'll tap into nerve endings surgically to heighten the total effect, it is more likely that a helmet fitted over your head will have the desired effect. Electronic? Of course.

Students of metaphysics declare that everyone who ever lived is recorded in the "Akashic" records "out there" in the sixth dimension. Assume that there is such a record, most certainly one day a workshop experimenter will discover the way to tap that great recording at will and select out one at a time of the billions of recordings that exist in that "other dimension," like tuning across AM, FM, SSB, CB, etc. frequency bands. Through the simple application of tuned resonance or PLL, we'll separate each (recording) to be received serially, and the roar of "pure noise" will change to recognizable intelligence.

To any who say that everything's been invented, I can only reply, "There are more things in heaven and earth, Horatio, than are dreamed of in your philosophy!"

A READER
Geyserville, CA

HEAT ENGINE EFFICIENCY

Mr. Smiles' letter in the August 1978 issue merits congratulations for compactness, but I have never seen so much misinformation packed in so little space!

The limiting efficiency of heat engines (of which the internal combustion engine is one type and not the most efficient, at that) is determined by the second law of thermodynamics. According to this law, the limiting efficiency is determined by the equation:

$$E = \frac{T_h - T_c}{T_h}$$

where T_h represents the high-temperature side of the engine and T_c , the low-temperature side of the engine.

For an internal combustion engine, the high temperature can be taken as the combustion temperature, which is approximately 1700°C or 2000°K (Kelvin or absolute temperature); my conversion is not exact, but the value is only approximate.

The low temperature is the temperature at which the gas is exhausted from the cylinder, which can be taken as 500°K. Then, the theoretical limiting efficiency of such an engine is easily calculated as 75%, which is far greater than Mr. Smiles' value of 30%.

It is true, of course, that present-day internal combustion engines are far less efficient than the value calculated above. This is due to *practical* limitations on what type of engines can be constructed economically, a far cry from the theoretical limitation Mr. Smiles complains about.

However, there is an even greater flaw in his argument. This lies in assuming that the efficiency of converting light into electricity by a photovoltaic cell is limited by the same considerations that limit heat engines, when in fact such a cell is not a heat engine. The best analogy in this case is that of a storage battery that is charged and discharged at the same temperature. If heat-engine considerations were applied to this case, the above equation would indicate that $E=0$, so that no matter how much energy you could transmit to the battery, none would be extracted. However, real storage batteries are 80% to 90% efficient, as is the photocell. There is no *theoretical* reason why the efficiency could not be created as high as desired, although there may be *practical* reasons for not doing so.

DR. HOWARD MARK
Suffern, NY

CABLE TV CONVERTERS

With reference to the Looking Ahead article regarding the problem of cable TV converters used with VTR's, perhaps you'd be interested in a few of the tricks we've come up with to get around the converter hassle.

The first is quite simple: A few of the converter-only channels have harmonics that fall into the standard VHF TV broadcast frequencies, although not, of course, right on top of the existing channels. If you off-tune the fine-tuning adjustment far enough, these harmonics can be received as clearly as on Channels 2-13, without a converter box. Just what can be received this way will vary from cable company to cable company; obviously not all stations can be picked up without the little black box (actually ours is brown). For a start, Channel "1" comes in just off Channel 7. Most color sets and some black-and-white sets have enough range to pull in these extra channels. Presumably, the tuners on VCR's can also receive them (all our VTR's are studio models without integral tuners, so I don't know for sure).

The second trick is a bit more complex: We "borrowed" it from Philips. Here in Canada converters cost around \$100 a shot, except for Philips' little black box, which goes for \$45. Rather than having a mass of buttons and a varactor tuner, their "converter" is just an oscillator that shifts everything up into the TV's UHF frequency band, where the UHF tuner can sort out the extra channels, much like the front end of a superheterodyne radio. We've built up several circuits to do this, and, of course, they are very simple.

Thank you for the prolific video material you put into **Radio-Electronics**.
STEVE RIMMER
The Underground Tube
Markham, Canada

equipment reports

AP Products Powerace Model 103 Breadboard Systems

THE POWERACE SERIES OF SOLDERLESS breadboarding systems manufactured by AP Products adds the convenience of combining various built-in power supplies, meters, LED indicators, switches, debouncing circuits, and pulse and clock generators on the basic plug-in matrix boards. If you do a fair amount of IC breadboarding, the usefulness of built-in sources and monitors is well worth their additional cost.

The model 103 Powerace includes three fixed-voltage power supplies. The alternative is to use three separate, or even combined, supplies, which, with their bulk and interconnecting leads, add greatly to the cost of a basic breadboarding system and severely restrict its portability.

In the Powerace model 103, a slanted control panel contains the data and logic



CIRCLE 132 ON FREE INFORMATION CARD

switches, power-supply distribution buses, a voltmeter and an ON-OFF switch. The nearly horizontal breadboarding section is a 1680 terminal—a solderless panel composed of two AP Products Super Strips.

The Powerace model 103 has self-contained +5-volt power supplies, plus tracking +15-

volt and -15-volt power supplies. Ripple and noise measurements are less than or equal to 10 mV under full load, and load and line regulation is better than 1% for all three power supplies. The 5-volt supply is current-rated to 650 mA, and the 15-volt supplies are rated to 250 mA each. The power supplies are protected with a 1-amp fuse in the transformer primary, and their outputs are brought out to four-terminal distribution buses.

The zero-center, 5% accuracy voltmeter is calibrated from -15 to +15 volts and is wired to a solderless bus strip on the panel. One side of the meter and its corresponding four terminals are wired to the power-supply ground.

Two LED driver/displays (L1 and L2) are mounted on the control panel; each consists of an LED and a single solderless terminal that is used to jumper to the logic points that will be monitored on the breadboard section. Each LED indicator is driven by a Darling-ton-transistor-connected circuit with an LED current-limiting resistor and a 100K base input resistor. The maximum input drive current is 1 μ A.



NOTHING BEATS WRAP-WIRING for changeable, fast and reliable connections if you use **NEW VECTOR WRAP POSTS** and unique **"SLIT-N-WRAP"™** daisy chain wiring tools.

Rectangular shanks press into .041" diameter holes tightly. Posts are .025" sq.

Sharp corners on wrap posts bite into wire for best contact.

Pyramidal ends slide easily into wrapping bits.

Install into cards with low cost manual gang insertion tools.

1. **T46-4-9 NAIL HEAD**, .032" high, pin length .30". \$16.91 per thousand.
2. **T68 SLOT HEAD**, .090" deep, pin length .34" (.36 pin length also available). \$16.40 per thousand.
3. **T49 TRIFURCATED Klip** wrap post. Pin length .54". (Pin length .039" also available.) \$18.12 per thousand.
4. **R32 SOCKET PINS** fit DIP tabs and have .50" pin length below. \$112.42 per thousand.
5. **T46-3-9 WRAP POST**, double end, .42" pin length above and .48" below. \$20.90 per thousand. (Three other lengths also are offered.)
6. **P184 SLIT-N-WRAP** tool with wire. No pre-strip or cut. \$30.00.


Write for free samples of all five wrap post designs.



**VECTOR ELECTRONIC COMPANY, 12460 Gladstone Av.,
Sylmar, California 91342
(213) 365-9661, TWX (910) 496-1539**
Prices subject to change without notice.

CIRCLE 55 ON FREE INFORMATION CARD

THIS SIGN



ON YOUR DOOR
(wall, truck, or caddy)

TELLS YOUR CUSTOMERS
THAT YOU ARE THE P.R.I.D.E.
OF ELECTRONICS SERVICE

Your NESDA membership says you are:

Professional, Reliable, Industrious,
Dependable and Ethical

Don't YOU want to
say nice things about
YOUR business?

JOIN NESDA

write for information to:
NESDA, 1715 Expo Lane
Indianapolis, IN 46224

An Extraordinary Offer to introduce you to the benefits of Membership in

ELECTRONICS BOOK CLUB

invites you to take
this 1,302-page
robotics library
for only

\$199

You
Get ALL
FOUR of These
Huge Books
For Only
\$1.99

Build Your Own Working Robot

Complete instructions—plans, schematics, logic circuits, and wiring diagrams—for building Buster, the most unique pet in the world! Not for novices, Buster is a sophisticated experiment in cybernetics. You build him in 3 phases, and watch his personality develop as you add progressively more advanced circuitry to his mainframe. The first-phase robot, Buster I, is "leash-led," and dependent on his master for decision-making; Buster II has a basic brain, equipped with a wireless mike, he enters a room and talk with the occupants. Buster III responds when called, and when "hungry" finds his charger, and plugs himself in. Watch his personality evolve as you build him from the ground up in a learning experience unparalleled in electronic construction. 238 pgs., 117 illus. List \$8.95.

Handbook Of Remote Control & Automation Techniques

A practical, step-by-step guide to designing, building, and installing hundreds of remote control systems, and scores of automated devices. In over 200 pages, you'll learn how to interface a microprocessor with household devices. You'll learn how to apply electronic and mechanical techniques to remote-control with computers, with audible tones, with ultrasonics, with radio waves, with light beams, with dozens of special systems. You can build light and power failure sensors, position indicators, tone-operated systems, tone generators, RC hydraulic devices, and you'll see how to interface mechanical devices, hydraulic systems, and electric motors with electronic systems. 294 pgs., 250 illus. List \$12.95.

Digital Interfacing With An Analog World

A GIANT 406-page handbook that shows you how to design out the interface microprocessors, computers, telephones, and other digital devices with the analog world. That shows you how to really put your microcomputer to work to measure certain conditions, or to control external devices. Tells you all about how to go about it—how to convert energy produced by pressure, force, position, temperature, etc. into an electrical voltage or current your microcomputer can deal with. It shows you, tells you, describes and discusses things you can do with those I/O ports other than connect them up to a predefinitive peripheral! It's a "meaty" volume chock-full of practical info on a wide range of topics for engineers, computer hobbyists, engineering technicians, and robotics builders. 406 pgs., 277 illus. List \$12.95.

The Complete Handbook Of Robotics

How to design and build ANY kind of robot...including ones with microprocessor "brains"—PLUS how to interface robots with computers! It's a single sourcebook that contains all the techniques you'll need for creating, designing, building, and operating your own robot from beginning to end...with enough options to create a whole family of robotic wonders—controls can be electrical or electronic, power can be electrical, hydraulic, or pneumatic, your robot can operate by radio control or with a full range of sensors to move about on its own. This practical volume gives ALL the info needed to build a walking, talking friend and companion, or even a helpful servant. Includes 7 chapters on advanced robot circuits, controls, and sensors. 364 pgs., 137 illus. List \$12.95.

Let us send you this 4-volume, 1,302-page Robotics Library as part of an unusual offer of a Trial Membership in Electronics Book Club.

Here are quality hardbound volumes, each especially designed to help you increase your know-how, earning power, and enjoyment of electronics. Whatever your interest in electronics, you'll find Electronics Book Club offers practical, quality books that you can put to immediate use and benefit.

This extraordinary offer is intended to prove to you through your own experience, that these very real advantages can be yours...that it is possible to keep up with the literature published in your areas of interest, and to save substantially while so doing. As part of your Trial Membership, you need purchase as few as four books during the

coming 12 months. You would probably buy at least this many anyway, without the substantial savings offered through Club Membership.

To start your Membership on these attractive terms, simply fill out and mail the coupon today. You will receive the 4-volume Robotics Library for 10-day inspection. YOU NEED SEND NO MONEY. If you're not delighted, return the books within 10 days and your Trial Membership will be cancelled without cost or obligation.

ELECTRONICS BOOK CLUB, Blue Ridge Summit, Pa. 17214

Facts About Club Membership

- The 4 introductory books carry a publisher's retail price of \$47.80. They are yours for only \$1.99 for all 4 (plus postage/handling) with our Trial Membership.
- You will receive the Club News, describing the current Selection, Alternates, and other books, every 4 weeks (13x a year).
- If you want the Selection, do nothing. It will be sent to you automatically. If you do not wish to receive the Selection, or if you want to order one of the many Alternates offered, you simply give instructions on the reply form (and in the envelope) provided, and return it to us by the date specified. This date allows you at least 10 days in which to return the form. If, because of late mail delivery, you do not have 10 days to make a decision and so receive an unwanted Selection, you may return it at Club expense.
- To complete your Trial Membership, you need buy only four additional monthly Selections or Alternates during the next 12 months. You may cancel your Membership any time after you purchase these four books.
- All books—including the Introductory Offer—are fully returnable after 10 days if you're not completely satisfied.
- All books are offered at low Member prices, plus a small postage and handling charge.
- Continuing Bonus: If you continue after this Trial Membership, you will earn a Dividend Certificate for every book you purchase. Three Certificates plus payment of the nominal sum of \$1.99 will entitle you to a valuable Book Dividend of your choice which you may choose from a list provided Members.

ELECTRONICS BOOK CLUB

Blue Ridge Summit, Pa. 17214

Please open my Trial Membership in ELECTRONICS BOOK CLUB and send my 4-volume Robotics Library, invoicing me for only \$1.99 plus shipping. If not delighted, I may return the books within 10 days and owe nothing, and have my Trial Membership cancelled. I agree to purchase at least four additional books during the next 12 months after which I may cancel my membership at any time.

Name Phone

Address

City

State Zip

(Valid for new Members only. Foreign and Canada add 15%.) RE-29

The *model 103's* instruction sheet comes complete with schematic and parts list so you know just where you stand in case you try some unconventional hookup. An optional breadboard jumper wire kit (No. 923351 JK1) contains a set of 350 No. 22 wires in 14 lengths—.01 to 5 inches; the kit sells for \$10. The *Powerace model 103* is priced at \$124.95. AP Products Incorporated, Box 110-Q, 72 Corwin Drive, Painesville, OH 44077. **R-E**

Here comes the handy part: Both voltage ranges *and* the resistance ranges are *autoranging*. You can read any voltage from 0.01 to 1000 VDC without any adjustment; all you have to do is move the test leads! Just "stick 'em on" there and read the meter. Other features include fully automatic decimal-point placement and zeroing. Only the two lowest

The *model 462* is powered by four heavy-duty type AF NiCad batteries. A special charging unit with a recessed plug comes with the instrument. Fully charged batteries provide eight hours of use. The charger can be left permanently plugged in for bench work. For portable use, just pull the charger plug and take off. For emergencies when the heavy-duty batteries are not available, four AA NiCad batteries can be used, but they will provide only six hours of use.

54 West 45 Street, New York, N.Y. 10036 212-687-2224

THE TEST EQUIPMENT SPECIALISTS

**"General Electric
is your most complete source
for general line and industrial
electronic components."**



Your reputation is our reputation
Tube Products Department • Owensboro, Kentucky 42301

GENERAL  ELECTRIC

Train with NTS for the MicroComputers, digital the first name



Industrial Electronics

The world of electronics is daily becoming more challenging. Technology is growing more specialized, and the importance of digital systems increases every day. Test instruments, home entertainment units and industrial control systems are all going digital. And now, NTS training programs include a wider choice of solid-state and digital equipment than ever before offered in any home study course: Advanced NTS/Heath digital color TV (25" diagonal with optional programming capability), NTS/Heath microcomputer, digital test equipment, digital stereo receiver (70 watts per channel), NTS compu-trainer, plus much more state-of-the-art equipment to make your training exciting and relevant.

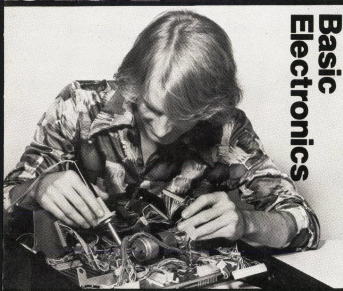
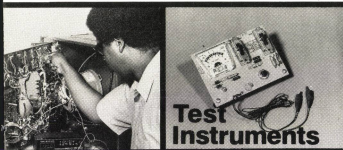
The equipment you receive with NTS training programs is selected to provide you with a solid

background in electronic systems. Kits and lessons are designed to work together to demonstrate electronic principles and applications. The kit-building not only shows you how electronic hardware functions, but how various circuit designs accomplish different purposes. Your lessons guide you through any number of experiments associated with many projects. This is the Project-Method, and it works. Step-by-step, you learn how and why digital electronics has become a part of our world, and the even bigger role it is sure to play in the future.

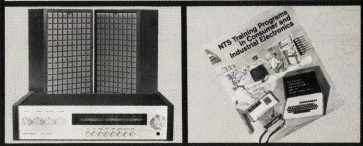
Whether you are looking for training in Consumer, Commercial, or Industrial electronics, NTS offers fourteen courses, some basic, many advanced, in several areas of electronics. An all-new full-color NTS catalog shows you what each course covers,

electronics of the future.

systems and more...from
in home study.



Simulated TV Reception



and every piece of equipment included.
Send for it today, and see for yourself what's really
happening in electronics training technology at NTS.
Find out how much has changed, and what new
directions the field is taking. You'll probably want to
be a part of it.

It's free. Just mail the card or coupon. Today.

NO OBLIGATION. NO SALESMAN WILL CALL.
APPROVED FOR VETERAN TRAINING.

NATIONAL TECHNICAL SCHOOLS

TECHNICAL-TRADE TRAINING SINCE 1905
Resident and Home-Study Schools
4000 South Figueroa St., Los Angeles, Calif. 90037

NATIONAL TECHNICAL SCHOOLS

Dept. 206-029

4000 South Figueroa Street, Los Angeles, California 90037

Please send FREE Color Catalog and Sample Lesson.

- ☐ Color TV Servicing
- ☐ B & W TV and Radio Servicing
- ☐ FCC License Course
- ☐ Electronic Communications
- ☐ Electronics Technology
- ☐ Audio Electronics Servicing
- ☐ Digital Electronics
- ☐ MicroComputers/MicroProcessors

Name

Address

Apartment Number Age

City

State Zip

☐ Check if interested in G.I. Bill information.

☐ Check if interested ONLY in classroom training in Los Angeles.

You have your own calculator. Why not a DMM?



Finally, a digital multimeter that's yours, just like your pocket calculator, and more useful. Only \$169.*

You pack only 13 ozs. in your pocket or service kit, but size is deceptive. The 8020A has more useful features than any other multimeter available—at any price! Features like 26 ranges and seven functions, including *conductance*. 2000-count resolution. Hi/lo power ohms.

And it's rugged. The high-impact case protects a minimum number of component parts (47 in all), and they're all readily available from any of the worldwide Fluke service centers. Your 8020A is factory calibrated by NBS traceable equipment. And we guaran-

tee it'll live up to published specs for a full year.

The 8020A is a true field instrument, designed with a highly readable LCD display, and inexpensive 9V transistor battery power for continuous use up to 200 hours. Reliability, quality and value: *that's* Fluke tradition.

To get your hands on one, call (800) 426-0361, toll free. Give us your charge-card number and we'll ship an 8020A the same day. Or, we'll tell you the location of the closest Fluke office or distributor. *Alaska, Hawaii and Washington residence. Please call 206-774-2481.

*U.S. price only.

The DMM for Home Electronics Experts.



CIRCLE 47 ON FREE INFORMATION CARD

EQUIPMENT REPORTS continued from page 26

The model 462 is well protected against accidental overload. Over-voltage protection is provided to 1000 volts on all autorangeing modes and to 650 volts on even the manually selected 0-200-mV ranges. The AC ranges are protected up to 600 volts on the autorange, to 240 volts RMS on the two low ranges, and to 650 volts on the higher ranges. Even the ohmmeter ranges are protected against over-voltage up to 250 VRMS on all ranges. I made the stock AC rejection test, and it came out beautifully.

The model 462 is compact enough to carry in a tube-caddy or kit, yet versatile and accurate enough for any kind of electronics work. A large handful of usefulness in a very small box and it costs \$185. **R-E**

6502 Editor Assembler

CIRCLE 125 ON FREE INFORMATION CARD

THE 6502 MICROPROCESSOR HAS RECENTLY become very popular, and the success of the Commodore PET and Rockwell's support as a second source have increased its appeal. For those who have worked with KIM, Apple or JOLT computers, the available software has been only occasionally listed in magazines here and there. Carl Moser has now developed an editor-assembler that lets you create a source mnemonic listing, assemble it, execute it, store it on tape and relocate the assembled program anywhere in memory.

This enhanced version of an earlier edition uses about 5200 words of memory for the program itself, and is designed for computer systems with at least 8K of memory. The suggested partitioning is about 400 words for the object-code file, a matching 400 words for the label file and 2000 words for the text file. While the program can be reduced to about

continued on page 34



Get every excitement-packed issue of Radio-Electronics delivered to your door. And save money, too—up to \$9 off newsstand prices! Use the handy coupon and subscribe today!

Mail to: **Radio-Electronics**
SUBSCRIPTION DEPT., P.O. BOX 2520,
BOULDER, COLO. 80323 (please print)

Name		
Address		
City	State	Zip Code

Indicate the offer you prefer:

- ☐ 1 Year—12 issues ONLY \$9.98 (You save \$5.02 off newsstand price.)
- ☐ 2 Years—24 issues ONLY \$19.00 (Save More! \$11.00 off newsstand price.)
- ☐ 3 Years—36 issues ONLY \$27.00 (Save Even More! Save \$18.00 off newsstand price.)
- ☐ Payment enclosed ☐ Bill me
- ☐ Check here if this is a new subscription.
- ☐ Check here if you are extending or renewing your subscription.
- Extra Shipping: Canada \$3.00 per year, all other countries \$5.00 per year.

40B9



fact: you can choose your microphone to enhance your sound system.

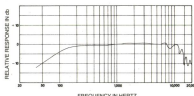
Shure makes microphones for every imaginable use. Like musical instruments, each different type of Shure microphone has a distinctive "sound," or physical characteristic that optimizes it for particular applications, voices, or effects. Take, for example, the Shure SM58 and SM59 microphones:

SM59

**Mellow, smooth,
silent...**

The SM59 is a relatively new, dynamic cardioid microphone. Yet it is already widely accepted as a standard for distinguished studio productions. In fact, you'll often see it on TV... especially on musical shows where perfection of sound quality is a major consideration. This revolutionary cardioid microphone has an exceptionally flat frequency response and neutral sound that reproduces exactly what it hears. It's designed to give good bass response when miking at a distance. Remarkably rugged — it's built to shrug off rough handling. And, it is superb in rejecting mechanical stand noise such as floor and desk vibrations because of a unique, patented built-in shock mount. It also features a special hum-bucking coil for superior noise reduction!

Some like it essentially flat...

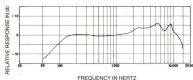


SM58

**Crisp, bright
"abuse proof"**

Probably the most widely used on-stage, hand-held cardioid dynamic microphone. The SM58 dynamic microphone is preferred for its punch in live vocal applications... especially where close-up miking is important. It is THE world-standard professional stage microphone with the distinctive Shure upper mid-range presence peak for an intelligible, lively sound. World-renowned for its ability to withstand the kind of abuse that would destroy many other microphones. Designed to minimize the boominess you'd expect from close miking. Rugged, efficient spherical windscreen eliminates pops. Lightweight (15 ounces!) hand-sized. The first choice among rock, pop, R & B, country, gospel, and jazz vocalists.

...some like a "presence" peak.



professional microphones...by



Shure Brothers Inc., 222 Hartrey Ave., Evanston, IL 60204, In Canada: A. C. Simmonds & Son Limited
Manufacturers of high fidelity components, microphones, sound systems and related circuitry.

CIRCLE 2 ON FREE INFORMATION CARD

EQUIPMENT REPORTS

continued from page 32

4400 words, this means sacrificing some functions, including one of the best—the EDIT command.

For maximum system flexibility and use, two external pieces of hardware are required: an audio cassette recorder, and a separate playback cassette machine. The system also supports a CRT, keyboard and printer.

The text editor, which occupies half of the program space, executes 20 commands. The AUTO command sets up automatic line numbering with user-specified increment size. Text files can be loaded, renumbered, recorded and printed. The RUN command executes an assembled program; the ASSEMBLE command calls the assembler; and the MANUSCRIPT command suppresses line numbers when listing. The EDIT command performs text file searches to change or delete selected alphanumeric characters within specified line-number ranges.

The assembler recognizes labels up to 10 characters long and has five conventional fields: line number, label, mnemonic, operand and comment. Assembly can be performed from the text file that was previously created with the text editor or from tape. Programs longer than available memory storage space are assembled from tape.

The first assembler pass generates the symbolic table (label file) and outputs whatever errors are detectable at that stage. A second pass creates the object file and output listings. An optional third assembler pass creates an

object file in relocatable format. A series of 16 pseudo-ops allow you to control assembler features such as continuing assembly in spite of low severity errors, as well as storing data bytes.

There are six listings: First, a hexadecimal dump program that produces a formatted object-code output listing. The next four listings are commented source listings, including break detection, motor control, relocating loading and tape loader software. The system is recorded on a cassette tape for easy initialization. The cassette loading program must be performed manually since it prepares the computer to load the editor-assembler tape itself.

The cassette tape, a 24-page manual and the program listings are available for \$30 from C. W. Moser, 3239 Linda Drive, Winston-Salem, NC 27106.

R-E

Hustler Model MOT Monitor Antenna

WITH THE WIDESPREAD USE OF THREE-BAND (low-VHF, high-VHF and UHF) programmable scanners, more and more antenna manufacturers are meeting the demand for compatible three-band monitor antennas. New-tronics Corporation (15800 Commerce Park Drive, Brookpark, OH 44142) has recently introduced the Hustler model MOT monitor antenna. The model MOT is available only as a trunk-mount unit. It performs well on the three frequency ranges for which it was designed—37–50 MHz, 150–174 MHz and 450–512 MHz.

The model MOT comes equipped with 16

feet of RG-58 coaxial cable, and is terminated with a Motorola antenna plug.

The model MOT is a center-trap antenna designed to act as a 16-inch one-quarter-wave whip when operating in the high-VHF band, and it automatically couples an additional 18 inches of active length (including resonant trap) when operating in the low-VHF band. The lower 16 inches is used as a three-quarter-wave whip in the UHF band.

The mounting assembly is firmly secured, both mechanically and electrically, to the trunk lid of a car by tightening two Allen-head set screws (a wrench is provided).

Because the entire antenna when mounted measures less than 3 feet, the model MOT poses no particular problem when used under normal mobile operating conditions. No tuning or pruning of the antenna is required; it is factory-pretuned.

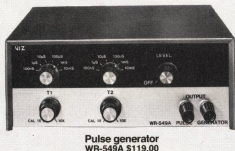
In our tests, the model MOT proved most satisfactory for a low-cost, three-band monitor antenna. Remember that a mobile antenna uses the vehicle body as part of a complete system, and unless the manufacturer's recommended application techniques are not followed closely, the antenna cannot be expected to perform at maximum efficiency.

The antenna comes in a blister package for rack display, with the element separated from the mount. The element is easily installed through a hole in a tightening nut and locked securely in place on the mount by a small wrench (also provided).

The model MOT monitoring antenna appears to be well designed and rugged enough to withstand most mobile monitoring applications. It is available for \$24.95.

R-E

Pulse and function generators for today's digital world



© VIZ
6642

Here are two new digital wave-form generators for today's logic designers and digital troubleshooters.

They're ideal for teaching, experimenting, or servicing digital-address TV tuners, binary digital instruments, digital clocks, small computers, calculators, TV games...practically anything digital.

- Pulse width adjustable from 100 nsec to 0.1 sec within 5Hz-5MHz range
- Output voltage adjustable from 0-15V at 600Ω, 0-6V at 50Ω
- On and off time independently adjustable
- Sine, sawtooth, and square-wave output 1Hz to 1MHz
- 4Vpp fixed-output for TTL and CMOS
- 10-V adjustable dc offset plus sweep
- Peak-to-peak output 0-20V at 600Ω

See them at your VIZ distributor.

**VIZ Test
Instruments Group**
of VIZ Mfg. Co.

335 E. Price St., Phila., PA 19144

Formerly
RCA
Instruments

Jim-pak®

electronic components

One-Stop Component Center

EXCITING NEW KITS!!

Regulated Power Supply



- ★ Uses LM 309K
- ★ Heat sink provided
- ★ P.C. board construction
- ★ Provides a solid 1 amp @ 5V
- ★ Includes components, hardware and instructions
- ★ Size: 3-1/2" x 5" x 2" high

JE200 5v 1amp

4-Digit Clock Kit



- ★ Bright .357" ht. red display
- ★ Sequential flashing colon
- ★ 12 or 24 hour operation
- ★ Extruded aluminum case (black)
- ★ Pressure switches for hours, minutes and hold functions
- ★ Includes all components case and wall transformer
- ★ Size: 3-1/4" x 1-3/4" x 1-1/4"

JE730

Function Generator Kit



- ★ Provides 3 basic waveforms: sine, triangle & square wave
- ★ Frequency range from 1 Hz to 100K Hz
- ★ Output amplitude from 0-volts to over 6 volts (peak to peak)
- ★ Uses a 12V supply or a $\pm 6V$ split supply
- ★ Includes chip, P.C. board, components and instructions.

JE2206B

NOW!!! OVER 300 AUTHORIZED DISTRIBUTORS... HERE'S JUST A SAMPLING:

ALABAMA Mobile ALASKA Anchorage ARIZONA Yuma CALIFORNIA Bellflower Berkeley Mission Viejo Monterey Oceanside Palo Alto Pasadena Sacramento San Carlos San Diego San Fernando San Francisco San Jose San Luis Obispo	Lafayette Radio Electronics TV Mart Yuma Electronics Earl's Hobby Shop Al Lasher Electronics Tower Electronics Corp. Zack Electronics Duke Radio Inc. Zack Electronics J & H Outlet Store Radio Shack A.S.C. Mira Mesa San Fernando Zack Electronics United Radio & TV Supply Mid-State Electronic Supply Quality Electronics Santa Cruz Electronics Santa Maria Santa Monica Sunnyvale Vallejo Walnut Creek	ILLINOIS (Continued) Oak Park Rockford Schaumburg INDIANA East Chicago IOWA Indianapolis KANSAS Wichita KENTUCKY Lexington LOUISIANA Baton Rouge MOBILE Meridian MARYLAND Churchville Dumfries La Velle Rockville Rockville Towson MASSACHUSETTS Pittsfield Waltham Worcester MICHIGAN Crawson Flint Lansing Midland Mt. Clemens Niles MINNESOTA Duluth Hawkins Hudson St. Paul MISSOURI St. Louis NEBRASKA Lincoln Lincoln	Secronics Inc. Imperial Computer Systems Data Domain Acro Electronics Corp. Electronic Limited Wichita Amateur Radio Equipment Company Radio-Electronic Equipment Co. Pelican Electronics Pelican Electronics Pelican Electronics Churchville Electronics Dumfries J & M Electronics Computer Workshop Rockville Healthkit Electronics Center Healthkit Electronics Inc. Healthkit Electronics Center Pittsfield Radio Co. Inc. Computer Mart Inc. RM Electronics Inc. Radio Supply & Engineering Healthkit Electronics Center Fulton Radio Supply Co. CompuStore Corp. The Computer Store Northwest Radio of Duluth Healthkit Electronics Center St. Paul St. Louis Beckman Electronics Conley Radio Supply Electronic Service & Dist. Altair Computer Center Scott Electronics Supply Inc.	NEBRASKA (Continued) Omaha Omaha NEVADA Las Vegas NEW JERSEY Cherry Hill Pompton Lake Ramsey NEW MEXICO Las Cruces NEW YORK Endwell Kingston New York Troy Utica NORTH CAROLINA Boone Durham Greensboro Raleigh NORTH DAKOTA Fargo OHIO Cincinnati Columbus Dayton Reynoldsburg OKLAHOMA Oklahoma City OREGON Albany Coos Bay Portland Salem PENNSYLVANIA Harrisburg Microcomputer Systems Inc. Healthkit Electronics Center York RHODE ISLAND Providence Pawtucket TENNESSEE Chattanooga Clarksville Gainesville	Healthkit Electronic Center Omaha Computer Store Century 23 Radio Shack Associate Store The Computer Emporium Computer Corner of New Jersey Typewriter Computer Store Mann's Electronic Supply Computer Tree Inc. Grylls Electronics Computer Mart of New York Trojan Electronics Am-Com Electronics Futureworld Byte Shop Byte Shop of Raleigh The Computer Company Mod Electronics Healthkit Electronic Center Altair Computer Center Universal Amateur Radio Bios, Bytes & Micros Oregon Ham Sales Portland Radio Supply Computer Pathways Jabbour Electronics City Jabbour Electronics City William's Data Comp. Div. Mastronics Wagon's Stereo Center	TENNESSEE (Continued) Knoxville Nashville TEXAS Amarillo Dallas Houston Houston San Antonio UTAH Midvale VIRGINIA Alexandria Arlington Charlottesville Hampton Norfolk Richmond Roanoke Virginia Beach WASHINGTON Longview Moses Lake Pasco Seattle Seattle Seattle Tacoma WEST VIRGINIA Morgantown Wheeling WILMINGTON Wilmington CANADA Alberta (Calgary) Ontario (Windsor) Quebec (Montreal) ENGLAND Berkshire SINGAPORE Singapore SINGAPORE Singapore	Byte Shop Electra Distributing Co. Computer Encounters Inc. CompuShop Altair Computer Center CompuShop Interactive Computers Shuman Electronics Supply Inc. Healthkit Electronic Center Alpine Electronic Supply Co. Computer Hardware Store Healthkit Electronic Center Lafayette Radio Lafayette Radio Ave Electronics Corp. C-Com The Computer Place Healthkit Electronic Center Progress Electronics Roe's Electronics Review Electronics Amateur Radio Supply C-Com Empire Electronics Personal Computers C & G Electronics Electra Distributing Co. Lafayette Radio Altair Electronics
---	---	--	---	--	--	---	---

ASK YOUR ELECTRONICS STORE TO STOCK JIM-PAK® TODAY!!

JIM-PAK® • 1021 HOWARD AVENUE, SAN CARLOS, CALIFORNIA 94070 • (415) 592-8097



TRUST US TO TAME YOUR ARC ENEMY.

High voltage used to be the enemy of field technicians.

In order to measure it accurately, they'd either have to tote bulky test equipment to the installation site, or tote the unit to the test bench.

Then, in 1967, ITT Pomona Electronics introduced the first high voltage test probe with a built-in meter.

This compact, lightweight instrument made high voltage trouble-shooting practical and convenient anywhere. And it became an instant success everywhere.

Now we make six different ITT Pomona Electronics high voltage test probes. There are models for color and black and white television, microwave ovens, neon signs, electronic air cleaner systems, etc.

Best of all, they're priced so low that every serviceman can have one along.

See our new catalog for details on the full high voltage test probe line. Plus more than 640 other products you know and trust. ITT Pomona Electronics, 1500 East Ninth Street, Pomona, CA 91766 • Phone: (714) 623-3463 • TWX: 910-581-3822

AVAILABLE THROUGH YOUR FAVORITE
ELECTRONIC PARTS DISTRIBUTOR

FREE 1979 YEARBOOK CATALOG

Contains 100 pages of adapters, cable assemblies, jacks, plugs, boxes, sockets, connectors, jumpers, clips, probes, patch cords, wire, and much more. Yours free upon request. See our pages in EEM.



Pomona Electronics **ITT**

CIRCLE 37 ON FREE INFORMATION CARD

String Synthesizer



An introduction to the latest innovation in electronic music synthesizers. The string synthesizer gives the soloist and small groups the background needed to enhance the performance.

MARVIN JONES

STRING SYNTHESIZERS, AND THEIR recent popularity, represent the culmination of over a decade's worth of work in developing and improving electronic music synthesizers. String synthesizers are the first of what we expect will be a long line of special-purpose instruments designed to avoid the clutter of patch cords and a strong technical background required to run the early breeds of synthesizers. Recent surges of interest in guitar and drum synthesizers indicate that these instruments will follow in the string synthesizers' path.

It is very natural that the string synthesizer was the first special-purpose synthesizer to come along. Since the inception of popular music, one of the staples of the "hit record" sound has been the lush, flowing orchestrated backgrounds. Unfortunately, few vocalists and solo musicians do well enough to allow hiring orchestras to perform live. Thus, the lush background was always missing in concerts. Organs helped, but weren't quite the same. Then there's always the problem of being able to afford an orchestra for the recording session in the first place! String synthesizers have changed all that. Now musicians are using these units to perform anything from country music to avant garde, in locations ranging from your neighborhood bar to Madison Square Garden!

Strangely enough, the basic circuitry in a string synthesizer is more a result of

combo organ technology than of synthesizer technology. The rich moving sounds they produce are so powerful that most anyone (musician or not) gets a kick out of playing with them. And all the commercially available units use the same basic circuitry to achieve the effect of violins and cellos 'en masse.'

This article will describe how to build a professional-quality string synthesizer, but first let's take a look at how these magical machines are used, and then

discuss how the circuitry works. The model 1550 synthesizer is of particular interest since it is available in kit form as well as assembled, and there are a number of options available such as stereo outputs and a microprocessor interface card. The instrument also produces a percussive electric-piano voicing.

How it is used

The majority of the features on string synthesizers can be found on the front

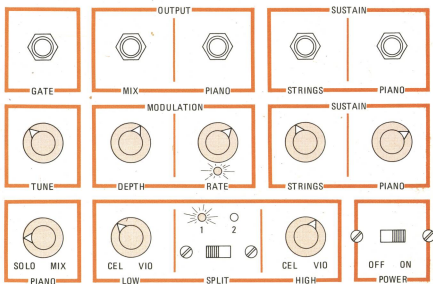
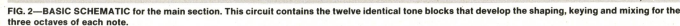


FIG. 1—LAYOUT OF THE CONTROL PANEL. It is operated with the left hand. Five jacks are provided for output and interfacing connections.

The GATE jack provides a voltage which steps from 0 to about +9 volts whenever a key is pressed on the keyboard. This allows the instrument to trigger external effects or processing equipment such as synthesizer modules. Many of the standard synthesizers manufactured today have an array of "systems interfacing" jacks to allow external signals to be processed and become the basis for more complex sounds with polyphonic synthesizer textures. When string synthesizers are used in this way, it is easy to synthesize "brass" sounds, and other special effects using the circuitry inside the syn-

There are two signal outputs on the stock synthesizer. The first is the MIX output, or the master output. At this jack will appear the sustained string voice, plus a variable mix of the electric piano sound. The second output provides only the PIANO signal. This output is useful if you wish to use separate mixing, equalization, or special effects for the two different voicings. When using a standard 1/4-inch 2-conductor phone plug in the PIANO jack, the piano signal is automatically removed from the composite signal at the MIX jack. This allows complete separation of the two types of signals if desired. Alternatively, you could use a 1/4-inch 3-conductor phone plug which has no connection made to the ring section of the plug. The piano signal will appear now at both output jacks, with the user selecting either or both outputs with the PIANO mix control (explained later).

The SUSTAIN jacks allow provisions for remote control of the amount of time it takes for a signal to fade out once the key is released. For those of you familiar with synthesizer terminology, this would actually relate to the "release" control on an ADSR (Attack, Delay, Sustain, Release) envelope generator. Note that there are separate, fully variable sustain controls for each of the two types of signals—string and piano. Some commercial units have only a long/short sustain switch, or no control at all. The most common use of the sustain jacks will be for sustain foot switches, which will operate much like the sustain pedal on an acoustic piano. When the two conductors of the jack are shorted together, the front panel sustain control will operate normally to set the minimum sustain time. When the foot switch contacts are opened, the sustain time increases to maximum as though the front panel control were turned to maximum. For the foot switch itself, a normally



closed momentary-contact switch can be used to provide action similar to acoustic piano sustain pedals, or a positive contact switch can be used to provide push-on, push-off sustain control action.

Internal design of the model 1550 synthesizer allows for use of variable foot pedals (such as pedal volume control voltage (0 to +5 volts) to remotely program the sustain times for either of the voices. This allows all the versatility of the front panel controls without requiring the musician to remove his hands from the keyboard.

The TUNE control is fairly standard. It allows the instrument to be tuned to other instruments, yet provides a full octave of transposition so you can extend the range of the instrument for special compositions. With a little practice, the TUNE control can even be used as a performance device, allowing orchestral glides or pitch blends for special effects.

Perhaps the most important and powerful controls on the model 1550 (or any string synthesizer) are those controls that allow the user to modify the operation of the chorusing and vibrato circuits. These controls are important in allowing each musician to alter the basic string sound to suit musical requirements or individual tastes. Unfortunately, this is where many commercial units fall short in the eyes of musicians. The chorusing circuitry is responsible for taking the single "reedy" voice of the organ circuitry and making it sound as if there are a great number of simultaneous voices occurring. This effect is obtained by using analog delay lines to generate two "echoes" of the original signal. The time delay is so short (constantly varying between 0.5 ms and 20 ms) that it is not heard as a distinct echo. Rather, it appears as if there is another instrument playing in unison with the original voice. With two delay lines, we can generate three-voice chorusing which is sufficient to confuse the human ear into believing it is hearing a large number of voices. By now you should see why this circuitry is so important to the effective generation of orchestral effects.

This synthesizer provides two controls for user alteration of chorusing effects. DEPTH determines the amount of chorusing in the effect. At minimum setting, there is no frequency modulation occurring at all, yielding a bland reed-organ voice. This would be useful for basic combo organ effects, or for external processing as mentioned earlier. As the DEPTH control is advanced, the two delayed voices are frequency modulated by an increasing amount. At approximate mid-rotation, the typical string chorus with vibrato is achieved. Further rotation of the control creates very heavy vibrato and pitch deviations of about a semi-tone for special effects.

The RATE control varies the speed of pitch fluctuations (vibrato) in the

chorusing circuitry. At minimum, the vibrato is so slow that it is not heard as actual pitch variations but as a rich, ethereal rolling effect similar to several phase shifters or flangers sweeping simultaneously. This control setting provides a thick pipe-organ effect that is actually spine-tingling! As it is advanced, the vibrato rate increases through normal settings to fast quivering vibrato for special effects. The adjacent LED indicates the speed of one of the low-frequency vibrato oscillators for use as a visual guide of control settings when you are on stage or in the studio.

The PIANO SOLO/MIX control is used to send the piano voice to either the master MIX output, or to the solo PIANO output. The control acts as a panning control, so the signal can be applied to the two outputs in any blend. When using only the MIX output, the PIANO control will act as a volume control for the amount of piano signal available in the master mix. When a standard 2-conductor 1/4-inch plug is used to carry the piano signal from the PIANO jack, the piano signal is disabled from the MIX jack and the PIANO MIX control will act as a volume control for the amount of signal appearing at the PIANO jack. When a 3-conductor plug is used (with no connection to the ring) for the piano output, the PIANO MIX control acts as a panning control to send variable amounts of piano signal to the two outputs. Interesting stereo imaging effects can be obtained with this configuration.

The large box of controls centered in the bottom of the panel is used to design the string voicing you desire. The SPLIT switch is used to select the point at which the keyboard can be divided. At position 1, the keyboard voicing will be split at the first octave. In position 2, the keyboard will split at the second octave. LED's show the selected split location at a glance. Once the split function is selected, the LOW mix control will set the desired blend of violins and cellos for all keys below the selected split position. The performer can select violins only, cellos only, or any combination of the two. It should be mentioned here that the cellos are 2 octaves lower than the violins.

The HIGH mix control serves a similar function for all keys above the selected keyboard split point. With these controls, you can easily configure the keyboard for the type of music you will be playing. For example, if the composition uses simple driving cello parts, but a violin part that moves and jumps over a wide range, then you would set the split switch for the first octave, and set the LOW mix for cellos and HIGH mix for violins. An infinite variety of voicings are available with these controls. The string mix and split controls take on added power when the stereo output is added to the unit. With the option installed, the selected split location can also become the point at which the stereo effect is split. Or, in an alternate

stereo operation mode, the violins can be routed to one side and cellos to the other side. In this mode, the LOW and HIGH mix controls are instrumental in determining the "width" of the stereo effect by determining the violin/cello content of each half of the keyboard.

How it works

The schematic for the main circuit is shown in Fig. 2. Three of the four gates in IC6 generate a high-frequency clock signal (around 1 MHz.) This clock signal is applied to the Top-Octave Generator, IC7, where it is divided by the twelve integers required to produce the twelve equally tempered frequencies of a scale. These frequencies will be divided into the lower octaves inside each of their respective tone blocks. Since the keyboard used in this synthesizer is actually 3 octaves plus one note (the highest "C"), additional circuitry must be provided for the tone generation of that extra note.

IC5 and associated resistors, capacitors, and diodes provide this function. This circuitry works exactly like the circuitry in the Tone Blocks, and will be discussed later. The additional circuitry in Fig. 2 shows the operation of the various front panel controls. The SPLIT switch, S2, generates a high (+V) or low (ground) logic signal which represents a high or low keyboard split location, respectively. The second section of S2 controls the LED SPLIT function indicators. Sustain controls, R52 and R54, generate control voltages that are variable from 0 to about +5 volts.

The selected control voltage is applied to the buses that run along the edge of the tone block circuit boards. Thus, this voltage is a master control that effects the sustain time of all thirty-seven notes of the keyboard. The sustain jacks, J1 and J2, provide an interrupt function for the sustain control voltage. When a plug is inserted into a jack, the voltage on that sustain bus can be remotely varied or switched (shunted) for variable sustain function. The MVH, MVL, MCH and MLH string voice signal buses (*Mix Violins High, Mix Violins Low, Mix Cellos High, and Mix Cellos Low*) are applied to mix controls, R55 and R56.

With these controls, the signals can be shunted to ground in the desired proportions. The resulting mixtures of string voices, as well as the raw piano-bus signal, is fed to additional circuitry for final processing.

In Fig. 2, also note that +V is applied to the common bus of the keyboard, and depression of any key provides, in effect, a logic signal to the tone block circuitry. A positive voltage designates a key being played. The open circuit of a released key is pulled back to ground by an input pull down resistor at each keying input of each tone block. Master buses running throughout the tone blocks also distribute +V, ground, and the split logic signal.

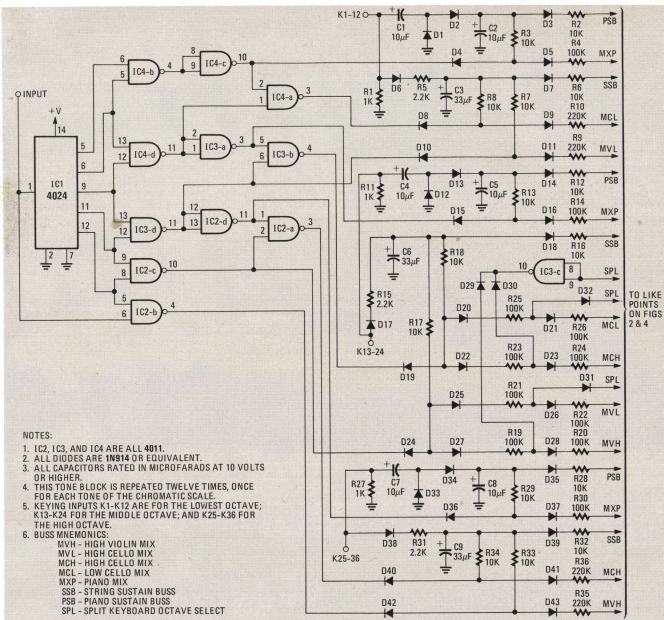


FIG. 3—CIRCUIT OF ONE OF THE TWELVE TONE BLOCKS. These identical circuits provide the necessary waveshaping, keying and mixing for all notes. The mixing and chording circuit (Fig. 4) will be presented next month.

The circuitry for one of the twelve tone blocks is shown in Fig. 3. This circuitry generates the waveshaping, keying, and mixing for three octaves of any chromatic note. The twelve tone blocks are identical and all are contained on two large PC boards in addition to the top octave and highest "C" circuitry discussed in the main schematic.

The whole process begins with the input of a high-pitched squarewave from the top-octave generator. This waveform switches between +V and ground, and directly drives the input of the tone block circuitry. IC1 is a 4024 7-stage counter which divides the input frequency into lower octaves. Only the first five divisions, plus the original input, will be used. The first bank of NAND gates (IC4-b and -d, IC3-d and IC2-b and -c) are driven by the counter and used to convert the squarewave signals to pulse waves with a 25% duty cycle.

The harmonic content of this type waveform more closely approximates the sound of a violin. The high-octave violin signal is obtained at pin 4 of IC2-b, while the middle-octave violin appears at pin 10 of IC3-d, and the low violin at pin 11 of IC3-d. The three lowest octaves of NAND gate outputs are additionally fed through inverters consisting of IC4-c, IC3-a, and IC2-d. This inversion maintains proper phase relationships so the remaining waveshaping circuit will operate correctly.

Immediately after inversion, these waveforms are selected for use as the piano signal. At this point, these waveforms still have a 25% duty cycle. Finally, NAND gates IC4-a, IC3-b, and IC2-a are used to mix the inverted waveform with the non-inverted waveform which originated one octave higher. The result is a pulse wave with a 12.5% duty cycle. The extremely wide harmonic spacing

occurring in this waveform very closely approximates a cello waveform, and is consequently used as the signal source for this voicing.

The remaining keying and mixing circuitry is roughly divided into three sections, one for each octave that will be keyed by the keyboard. Additionally, each of these three sections is further divided into a section for strings and another for the piano effect. The input terminal labelled K1-K12 is the lowest octave keying input. NOTE that there is actually only one input at this point to each tone block. However, this one point will be labelled differently for each chromatic tone block. For example: K1 will be in the "C" tone block, K2 in the "C#" tone block, and so on through K12 in the "B" tone block.

When a key is depressed, the keying input jumps to a positive voltage. The first thing to happen is the piano keying.

TO LIKE
POINTS
ON FIGS
2 & 4

PARTS LIST

The following lists the components according to type and quantity and is included as an aid to help you acquire the parts necessary to build the model 1550.

Resistors— $\frac{1}{2}$ -watt, 10% unless otherwise noted

- 5—10 ohms
- 1—100 ohms
- 5—470 ohms
- 46—1000 ohms
- 1—1800 ohms
- 37—2200 ohms
- 6—2700 ohms
- 6—4700 ohms
- 1—8200 ohms
- 205—10,000 ohms
- 1—15,000 ohms
- 3—22,000 ohms
- 147—100,000 ohms
- 50—220,000 ohms
- 1—170,000 ohms

Potentiometers

- 2—100 ohms, trimmer
- 5—1000 ohms, trimmer
- 1—50,000 ohms, trimmer
- 7—5000 ohms, linear taper
- 1—100,000 ohms, dual-section, linear taper

Capacitors

- 1—47 pF disc ceramic
- 2—100 pF disc ceramic

- 1—500 pF disc ceramic
 - 10—.001 μ F disc ceramic
 - 3—.01 μ F disc ceramic
 - 7—.05 μ F disc ceramic
 - 1—0.1 μ F Mylar
 - 12—1 μ F, 10 volts, electrolytic
 - 2—2.2 μ F, 10 volts, electrolytic
 - 4—5 μ F, 10 volts, electrolytic
 - 82—10 μ F, 10 volts, electrolytic
 - 37—33 μ F, 10 volts, electrolytic
 - 1—250 μ F, 20 volts, electrolytic
 - 1—1000 μ F, 20 volts, electrolytic
- ### Semiconductors
- 12—CD4024 7-stage divider (RCA, National, Motorola)
 - 37—CD4011 quad NAND gate (RCA, Motorola, National)
 - 1—MK50240 top-octave generator (Mostek, AMI)
 - 2—CD4013 Dual D-type flip-flop (Motorola, National, RCA)
 - 1—7805 positive 5-volts regulator (Motorola, National, Signetics)
 - 1—7905 negative 5-volts regulator (Motorola, National, Signetics)
 - 1—CA3080 transconductance amplifier (RCA)
 - 2—SAD-1-24 analog delay line (Reticon)
 - 4—566 voltage-controlled oscillator (Signetics, National)
 - 4—2N5139 or similar NPN transistor

- 1—2N5129, 2N3904 or similar PNP transistor

- 4—1N4003 rectifier diodes
- 527—1N914 silicon switching diode
- 3—TIL209 red light-emitting diode

Miscellaneous

- 1—power transformer, 24 VCT, 1A
- 40—fla clips
- 2—socket, 16-pin DIP (for SAD-1024's)
- control knobs, mounting hardware, case, line cord, etc.

Note: The following are available from Paia Electronics, 1020 W. Wilshire, Oklahoma City, OK 73116:

- 1550A PC board \$30.00 postpaid
- 1550B PC board \$30.00 postpaid
- 1550C PC board \$10.00 postpaid
- 1550LED PC board \$2.00 postpaid

(All boards are etched, drilled and screened with parts placement layout.)

Set of four PC boards \$70.00 postpaid
A 37-note (3-octave) organ keyboard
(Order No. AGO-37) \$60.00 plus \$5.00 postage and handling

Complete kit of parts including case, keyboard and step-by-step instructions
(Order No. 1550) \$295.00 shipped freight collect

Fully assembled unit (order No. 1550AS) \$600.00 freight collect.

The positive step-voltage that is dropped across R1 is differentiated by C1. The positive spike generated is sufficient to forward bias D2 and dump a charge on C2. Simultaneously, C1 is charging to absorb that +V which has been applied to it. By the time the positive charging spike for C2 falls and C1 has a full charge, D2 has become reverse biased, eliminating the front end of this circuit as a possible discharge path for the charge on C2. The only possible discharge is through R3 and R4 to the virtual ground of the piano mix bus (MXP). This R—C combination (R3, R4, C2) sets the maximum sustain time for the piano signal.

To get a variable amount of shorter sustain time, the voltage on the piano sustain bus (PSB) can be lowered from about +5 volts to ground with the front panel control. If this bus is anywhere lower than the peak charge of C2 (about +5 volts), D3 becomes forward biased, offering C2 a lower impedance discharge path through R2. This causes the charge on C2 to fall more rapidly than normal thus making the sustain time shorter. When the key is released, the drop in keying voltage across R1 causes a negative spike to be generated by C1. Diode D1 becomes forward-biased by the spike and shorts it to ground. Resistor R1 will then serve to quickly discharge C1, preparing the piano keying circuit for the next key depression.

The only remaining section of the piano circuit is the signal-gating (envelope or amplitude contour) circuitry built around D4 and D5. This circuit is the

standard diode-keying configuration that has been used in electronic organs for quite some time. The pulse wave being used as the piano-signal source is being continuously applied to the cathode of D4. While the piano circuit is at rest, C2 is discharged leaving the anode of D4 at ground. This leaves D4 continuously reverse-biased and stops any signal transmission through it. When a key is pressed, a pattern of rising and falling DC voltage is generated across C2 as described earlier. This voltage will now forward bias D4 and allow the piano signal to pass. When the piano signal happens to be at a high level (the top of the pulse wave), the voltage at the junction of D4 and D5 will be pulled up to a DC voltage equivalent to the charge remaining on C2. When the piano pulse wave switches to a low level (near ground), D4 conducts and the junction of D4 and D5 will be pulled nearly to ground.

This high-speed (audio frequency) switching continues until the C2 charge has been depleted via the discharge path through R3 and R4. From the previous discussion, we see that the charge on C2 has a sharp increase followed by a long decay. The audio signal passed through D4 and D5 takes on the same attack and decay characteristics, thus duplicating the effect of a plucked or hammered piano string.

Diode D5 is used primarily to avoid interaction with other notes which may be simultaneously applied to the audio mix buses. In addition to being one of the

major determinants of the timing for the piano effect, R4 is also used as a mixing resistor and gain-setting component for this one piano note.

The same low-octave keying input we have been discussing for the piano circuits will also be used to gate a violin and cello sound at the same time. The keying voltage applied to R1 will forward bias D6 and cause C3 to charge via R5. The larger value of C3 and the current limiting of R5 cause C3 to charge more slowly, generating a "softer" attack, to more closely imitate the build-up that occurs when a section of strings bows a new note. This DC voltage is concurrently applied to two diode keying sections. Resistor R8, D8, and D9 are used to gate the low-octave cello signal being applied to D8. Resistor R7, D10, and D11 impose envelope control on the violin signal.

The entire keying section for the top octave of the tone block is identical to the circuitry we have just covered. The high-octave keying inputs are K25 through K36, and the high-octave signal sources are tapped from higher frequency outputs of the NAND gate waveshaping circuit. Also, the violin and cello outputs from the high-octave keying are permanently connected to the high-violin and cello mix buses. Otherwise, the circuits are the same.

Next month we will discuss the power supply and the middle-octave mixing and chorusing circuits and then go on to construction details. This will include foil patterns for the PC boards and diagrams showing parts placement.

R-E

Solar Tracking System

Solar-energy collectors work best when constantly oriented to trap the most energy from the sun. This electronic servo system swivels the collector panel so it follows the sun across the sky.

RODNEY A. KREUTER

THE MOST COMMON USES FOR SOLAR energy systems today are space heating and hot-water preheating. These systems generally use nonmovable flat-plate collectors; and for a low-temperature system, flat plate is probably the best choice. If, however, your system needs high-temperature water or steam, or uses solar cells to generate electricity, a tracking system is the only way to go.

A solar tracking system consists of a motor-sensor combination that locates the sun and points a collector toward it. A non-sensing system can even be built using a constant speed motor, but such a system has more disadvantages than advantages.

The solar collector tracking system discussed in this article is intended as a guide, not as an absolute system. (For example, why track the sun if there is little or no energy to be gained?) We'll examine how to construct a simple circuit using a com-

parator that will not let the motor operate until a certain level of sunlight is present.

The basic system

Figure 1 shows a block diagram of the solar tracking system, which consists of four basic modules: 1) a pair of phototransistor sensors; 2) a difference amplifier; 3) a deadband amplifier; and 4) a servomotor and motor drive transistors.

Figure 2 shows how the phototransistor sensor is constructed. Note that the phototransistors are mounted on perpendicular surfaces so that a shadow effect occurs when the sun is not directly overhead.

The difference amplifier (see Fig. 1) subtracts the output of sensor B from the output of sensor A and multiplies the result by about 4.7.

The deadband amplifier is a fairly unique device. It amplifies the output of the difference amplifier by about

2.5 only if the output of the difference amplifier is greater than 0.6 volt

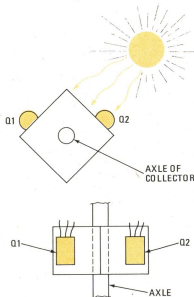


FIG. 2—PHOTOTRANSISTOR SENSORS are mounted at right angles to each other. The output of the sensors are equal when the sun is directly over the apex.

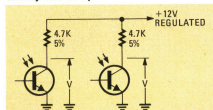


FIG. 3—PHOTOTRANSISTOR SENSORS must have matched outputs for correct circuit operation. Circuit above provides easy method for obtaining matched outputs.

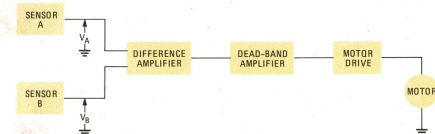
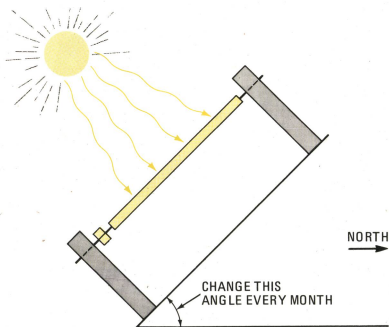


FIG. 1—SOLAR TRACKING SYSTEM uses phototransistor sensors to detect the position of the sun. Circuitry drives motor to position solar energy panels and minimize the difference in output from the two sensors.



or less than -0.6 volt. If the output of the difference amplifier is between -0.6 volt and 0.6 volt, the deadband amplifier provides a stable zero volt output.

The servomotor drive circuit consists of four push-pull Darlington connected transistors, which produce enough current to drive a fair-sized 12-volt motor.

Circuit operation

Two phototransistors are used as brightness sensors. When operated from a constant-voltage power supply, the collector current of each transistor is proportional to the amount of illumination they receive.

Due to variations in manufacturing processes, the phototransistors may not be well matched, so it is a good idea to buy a few extra phototransistors and match them yourself. The procedure is very simple.

First, breadboard the circuit shown in Fig. 3. Place two phototransistors side by side with the flat side down. Shine a *diffused* light source (a handkerchief placed over a bare high-intensity bulb will do) on the transistors. Note that the base connection is not used.

Apply power to the circuit and measure the voltage from one of the collectors to ground; this will be your reference transistor. Adjust the dis-

tance of the light source so that the reference voltage reads about 3. Measure the collector voltage of the second transistor and write it down. Repeat this procedure with a reference voltage of 6 and 9, measuring all the transistors against the same reference transistor. Select the two transistors that give the closest results for your sensors.

PARTS LIST

All resistors $\frac{1}{2}$ watt, 10%.

- R1—1000 ohms (to start—see text)
- R2—680 ohms (to start—see text)
- R3—500-ohm trimmer (to start—see text)
- R4, R6, R12, R13—100,000 ohms
- R5, R7—470,000 ohms
- R8—5000-ohm trimmer
- R9, R10—3300 ohms
- R11—10,000 ohms
- R14, R15—1000 ohms
- C1—C4—0.0001 μ F
- C5, C6—0.1 μ F
- D1—D4—1N914
- D5, D6—50-volt rectifiers (current rating depends on motor current)
- Q1, Q2—2N5777 photodarlington or equal
- Q3—2N2222
- Q4—MJE3055
- Q5—2N2907
- Q6—MJE2955
- A1, A2—Op-amps, dual 741, 1558, 747, two 741's, two 301's, etc. Pin numbers depend on type and case style; 3900 or 324 types not recommended.
- S1, S2—Normally closed switches
- M1—12-volt reversible motor
- Misc.—Power supply, case, shielded cable for sensors, etc.

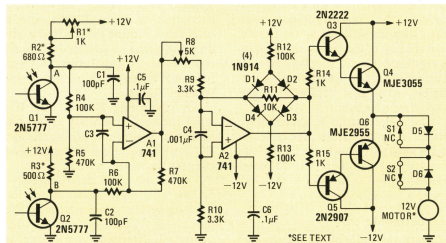


FIG. 4—CIRCUITRY detects difference in output from phototransistor sensors and switches the Darlington motor-drive transistors to minimize the difference.

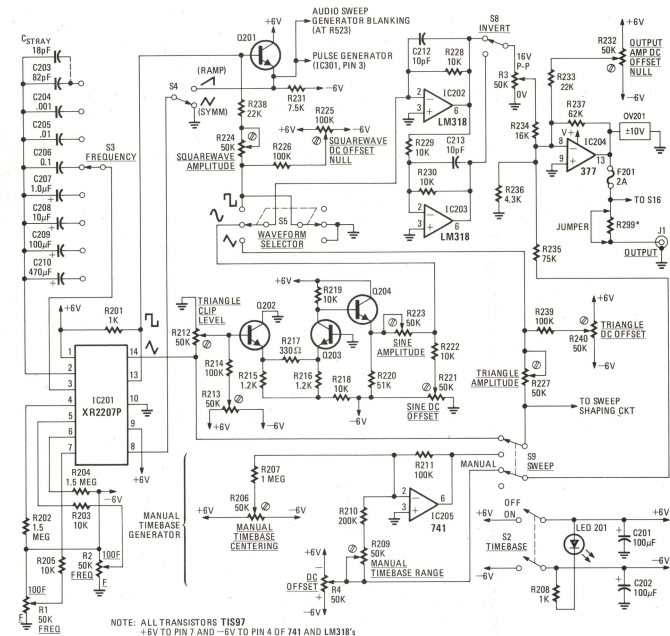


FIG. 4—THE TIMEBASE GENERATOR is designed around the Exar 2207 current-controlled oscillator. Frequency is determined by switchable capacitors and two slide pots on the front panel.

POWER SUPPLY

Resistors 1/4 watt, 5% unless otherwise noted

R101—82,000 ohms
R102—18,000 ohms
R103, R104—100,000 ohms
R105—2700 ohms

R106—330 ohms

Capacitors

C101—1000- μ F, 16-volt, electrolytic (two 500 μ F in parallel)
C102—500 μ F, 16-volt electrolytic
C103, C104, C107, C108—0.01- μ F disc

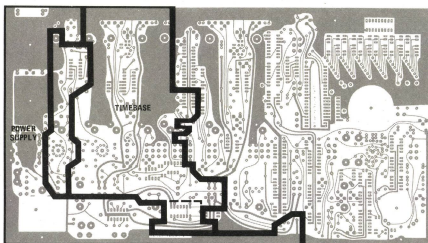
C105, C106, C115—10- μ F, 16-volt electrolytic
C109, C110—100- μ F, 16-volt electrolytic
C111—33- μ F, 16-volt electrolytic
C112—4.7- μ F, 16-volt electrolytic
C113, C114—0.001- μ F disc

Miscellaneous

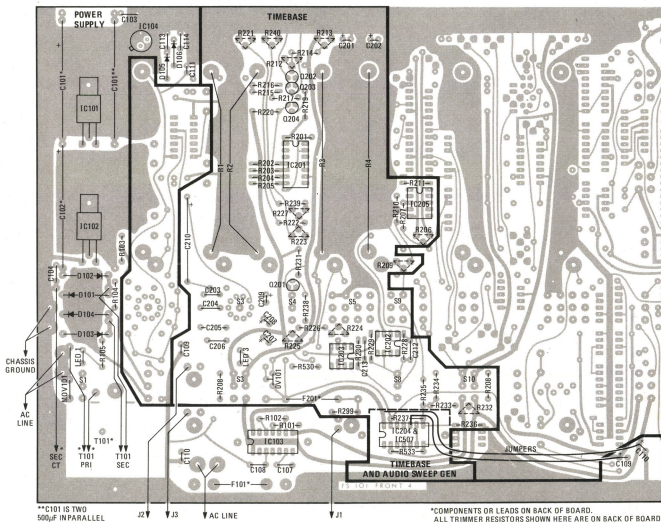
M0V1-V130LA10 thyristor
D101-D104—1N4001
D105-D106—1N4148
IC101, IC105—7812
IC102—7912
IC103—4194
IC104—309H
LED1, LED2—
T101—24-volt, 1-amp transformer
F101—
S1—SPST toggle switch
S21—DP3T toggle switch

The following are available from FSI, 1894 Commercenter W., No. 105, San Bernardino, CA 92408: Complete kit, \$495.00; cabinet and circuit board, \$115.00. Set of semiconductors, \$195.00; seven slide pots with knobs, \$17.00; set of trimmers including four multi-turn pots, \$17.00.

California residents add state and local taxes as applicable.

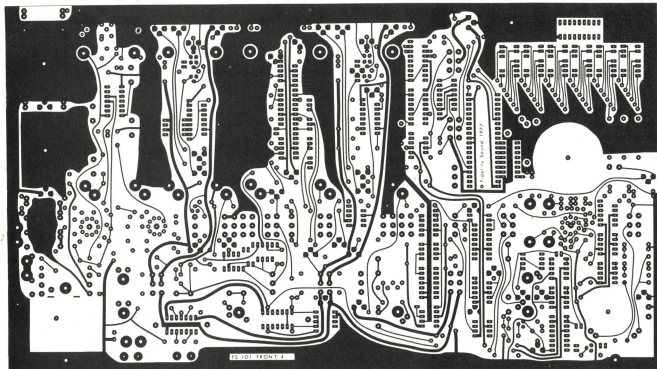


FOIL PATTERN of the component side of the PC board overlaid with the outlines of the power supply and timebase sections that are shown in the parts-placement illustration below.

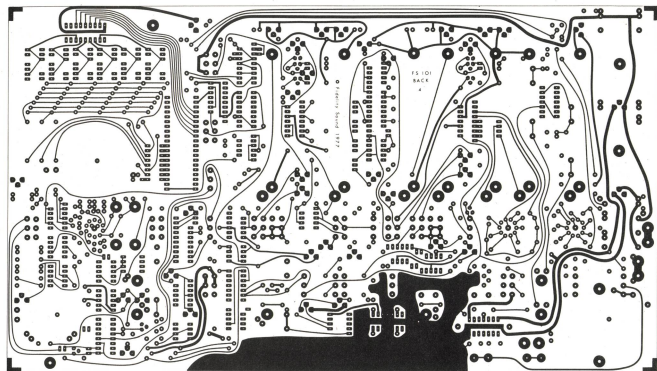


COMPONENT LAYOUT for the power supply and timebase generator are shown. Power supply parts are coded in the 100 series and timebase parts in the 200 series. Components on the front panel have codes beginning with 1.

**COMPONENTS OR LEADS ON BACK OF BOARD.
ALL TRIMMER RESISTORS SHOWN HERE ARE ON BACK OF BOARD.



PRINTED CIRCUIT PATTERN for the front side of the PC board shown half size. Most components are on this side.



FOIL PATTERN for the back surface of the board shown half size. It carries the fuses and most trimmers.

charging current supplied to the capacitor. The output of the integrator is then fed back to the comparator.

The integrator is essentially a constant-current source applied to a capacitor. If the current applied to the capacitor is constant, the change in voltage across that capacitor will also be constant. When power is applied, the output of the comparator begins to charge the capacitor through the constant-current source. This causes the voltage across the capacitors to rise linearly. When that voltage, which is

applied back to the comparator, reaches a predetermined point, the comparator switches states and begins to charge the capacitor in the reverse direction. This causes the voltage across the integrating capacitor to change linearly in the opposite direction.

The result is that the output of the integrator is a triangle wave and the output of the comparator is a squarewave. The peaks of the triangle wave align with the edges of the squarewave since it is these edges that cause the integrator to

change its output slope. If the charging rates represented by the plus and minus slopes of the integrator are equal, the slopes will be of equal magnitude and opposite sign, and, hence, both the triangle wave and the squarewave will be symmetrical.

The output of the integrator is at IC201 pin 14, and the comparator output is at pin 13. Both these outputs are buffered and do not represent the actual oscillator voltages.

continued on page 78

Cases And Cabinets For Your Projects

ONE OF THE MAJOR CONSIDERATIONS FACING THE amateur electronic experimenter and constructor is the physical layout and appearance of the finished project. In the days of vacuum tube and 12 by 16 in. chassis, most projects could be finished off nicely by adding a front panel and slipping the whole thing into a cabinet that could be handcrafted from wood or readily available sheet metals. Today, most electronic projects are assembled on printed-circuit boards or similar materials and are sometimes only one-tenth the size of its old vacuum-tube equivalent.

To select a case or enclosure that is most suitable for your project, you must have a pretty good idea as to what is available. Too, if your make and model specified in a magazine article is not available through your usual supplier, you should be aware of equivalents and possible substitutes. These charts list off-the-shelf enclosures, cases and chassis boxes in various material combinations, colors and sizes.

These charts list cases and cabinets not covered in the June and October 1978 issues of *Radio-Electronics*. While every effort has been made to ensure that these charts are as complete as possible, it is not always possible to include all the options and ordering information. It is, therefore, a good idea to obtain catalogs from the manufacturers.

To find out more about the products or distributors, a list of addresses of each manufacturer follows. To obtain a catalog, simply circle the corresponding No. on the Free Information card.

Apollo — Box 245, Vaughnsville, OH 45893. **Circle No. 135.**
Buckeye — 555G Marion Road, Columbus, OH 43207. **Circle No. 136.**

Bud Electronics — Dept. G., 4605 East 355 Street, Willoughby, OH 44094. **Circle No. 137.**

GC Electronics — Division of Hydrometals, Inc., Rockford, IL 61101. **Circle No. 138.**

Intra Fab, Inc. — 660 Lenfest Rd. San Jose, CA 95133. **Circle No. 139.**

Lafayette Electronics — 111 Jericho Turnpike, Syosset, NY 11791. **Circle No. 140.**

La France — Enterprise and Executive Avenues, Philadelphia PA 19153. **Circle No. 141.**

LMB Products — 725 Ceres Avenue, Los Angeles, CA 90021. **Circle No. 142.**

Premier Metals — 381 Canal Place, Bronx, NY 10451. **Circle No. 144.**

Radio Shack — 2617 West 7th Street, Ft. Worth TX 76107. **Circle No. 144.**

Rose/Stahl — 500 Maple Street, Belding, MI 48809. **Circle No. 145.**

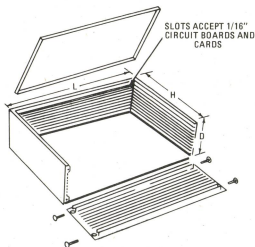
Scientific-Atlanta — Optima Enclosures-2166 Mountain Industrial Road, Tucker, GA 30084. **Circle No. 146.**

TenTec, Inc. — Dept. G., Industrial Park, Sevierville, TN 37862. **Circle No. 147.**

Vector Electronics Co. — 12460 Gladstone Ave., Sylmar, CA 91342. **Circle No. 148.**

Vero Electronics, Inc. — 171 Bridge Road, Hauppauge, NY 11787. (516) 234-0400. **Circle No. 149.**

Zero Mfg. — 777 Front Street, Burbank, CA 91503. **Circle No. 150.**



INSTRUMENT CASES

Internal side walls are grooved to position and hold PC boards. Both base and two side panels are removable for easy access to contents.

Length	Height	Depth	Mfr.	Model No.	Case Material	Comments	Options	Color
1.21	1.21	1.6	Vector	W-16-12-12B	Al	holds 1/16" p.c. cards	inner panels, base	consult mfr for latest colors
1.51	1.51	2.0	Vector	W20-15-15B	Al	holds 1/16" p.c. cards	inner panels, base	consult mfr for latest colors
2.31	3.81	1.0	Vector	W10-23-38B	Al	holds 1/16" p.c. cards	inner panels, base	consult mfr for latest colors

chart continued on following page

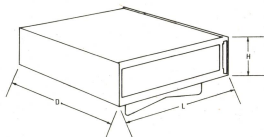
INSTRUMENT CASES

Length	Height	Depth	Mfr.	Model No.	Case Material	Comments	Options	Color
2.85	2.11	4.5	Vector	W45-28-21B	Al	holds 1/16" p.c. cards	inner panels, base	consult mfr for latest colors
2.85	4.61	1.6	Vector	W16-28-46B	Al	holds 1/16" p.c. cards	inner panels, base	consult mfr for latest colors
2.85	4.61	2.0	Vector	W20-28-46B	Al	holds 1/16" p.c. cards	inner panels, base	consult mfr for latest colors
3.10	2.11	1.6	Vector	W16-31-21B	Al	holds 1/16" p.c. cards	inner panels, base	consult mfr for latest colors
3.10	3.10	1.6	Vector	W16-31-31B	Al	holds 1/16" p.c. cards	inner panels, base; bezels	consult mfr for latest colors
3.10	3.10	2.0	Vector	W20-31-31B	Al	holds 1/16" p.c. cards	inner panels, base; bezels	consult mfr for latest colors
3.10	4.17	2.0	Vector	W20-42-31B	Al	holds 1/16" p.c. cards	inner panels, base	consult mfr for latest colors
4.61	2.11	4.5	Vector	W45-46-21B	Al	holds 1/16" p.c. cards	inner panels, base	consult mfr for latest colors
4.61	3.10	2.0	Vector	W20-46-31B	Al	holds 1/16" p.c. cards	inner panels, base; bezels	consult mfr for latest colors
4.61	3.61	2.0	Vector	W20-46-36B	Al	holds 1/16" p.c. cards	inner panels, base	consult mfr for latest colors
4.61	4.62	3.0	Vector	W30-46-46B	Al	holds 1/16" p.c. cards	inner panels, base; bezels	consult mfr for latest colors
4.61	6.17	2.0	Vector	W20-46-62B	Al	holds 1/16" p.c. cards	inner panels, base	consult mfr for latest colors
4.61	6.61	2.0	Vector	W20-46-66B	Al	holds 1/16" p.c. cards	inner panels, base; bezels	consult mfr for latest colors
6.61	3.61	2.0	Vector	W20-66-36B	Al	holds 1/16" p.c. cards	inner panels, base	consult mfr for latest colors
6.61	4.61	2.0	Vector	W20-66-46B	Al	holds 1/16" p.c. cards	inner panels, base; slide panels, bezels	consult mfr for latest colors
6.61	4.61	3.0	Vector	W30-66-46B	Al	holds 1/16" p.c. cards	inner panels, base; slide panels, bezels	consult mfr for latest colors
6.61	4.61	4.5	Vector	W45-66-46B	Al	holds 1/16" p.c. cards	inner panels, base; slide panels, bezels	consult mfr for latest colors
8.61	4.61	3.0	Vector	W30-86-46B	Al	holds 1/16" p.c. cards	inner panels, base; slide panels, bezels	consult mfr for latest colors
8.61	4.61	4.5	Vector	W45-86-46B	Al	holds 1/16" p.c. cards	inner panels, base; slide panels, bezels	consult mfr for latest colors
10	4.61	3.0	Vector	W30-100-46B	Al	holds 1/16" p.c. cards	inner panels, base	consult mfr for latest colors
10	4.61	4.5	Vector	W45-100-46B	Al	holds 1/16" p.c. cards	inner panels, base	consult mfr for latest colors
10	6.61	3.0	Vector	W30-100-66B	Al	holds 1/16" p.c. cards	inner panels, base	consult mfr for latest colors
10	6.61	4.5	Vector	W45-100-66B	Al	holds 1/16" p.c. cards	inner panels, base	consult mfr for latest colors
13	7	8	Bud	MD-1960	Steel	removable side & top	1963 for slope front	grey or blue

chart continued on following page

INSTRUMENT CASES

Length	Height	Depth	Mfr.	Model No.	Case Material	Comments	Options	Color
14	8	9	Bud	MD-1961	Steel	removable side & top	1964 for slope front	grey or blue
16	8	9	Bud	MD-1962	Steel	removable side & top	1965 for slope front	grey or blue



PORTABLE INSTRUMENT CASES

Modern design with handles and tilt stands available. Some are even adaptable to rack mounting.

Length	Height	Depth	Mfr.	Model No.	Case Material	Comments	Options	Color
5-7/10	3-1/2	13	Buckeye	3501	Al	concealed fasteners	tilt stand rack adapter	grey with suede-like finish consult mfr for color
5-7/10	5-1/4	13	Buckeye	5251	Al	concealed fasteners	tilt stand rack adapter	
5-7/10	7	13	Buckeye	7001	Al	concealed fasteners	tilt stand rack adapter	
5-7/10	8	13	Buckeye	8001	Al	concealed fasteners	tilt stand rack adapter	
5-7/10	8-3/4	13	Buckeye	8751	Al	concealed fasteners	tilt stand rack adapter	
5-7/10	10-1/2	13	Buckeye	1051	Al	concealed fasteners	tilt stand rack adapter	
8-1/2	3-1/2	13	Buckeye	3502	Al	concealed fasteners	tilt stand rack adapter	grey with suede-like finish consult mfr for color
8-1/2	5-1/4	13	Buckeye	5252	Al	concealed fasteners	tilt stand rack adapter	
8-1/2	7	13	Buckeye	7002	Al	concealed fasteners	tilt stand rack adapter	
8-1/2	8	13	Buckeye	8002	Al	concealed fasteners	tilt stand rack adapter	
8-1/2	8-3/4	13	Buckeye	8752	Al	concealed fasteners	tilt stand rack adapter	
8-1/2	10-1/2	13	Buckeye	1052	Al	concealed fasteners	tilt stand rack adapter	
8-1/2	2-7/16	9-1/4	La France	CH 200	ABS	detented tilt/carry handle	without handle	Stock and custom colors. Consult manufacturer
8-1/2	2-11/16	9-1/4	La France	CH 225	ABS		without handle	
8-1/2	2-15/16	9-1/4	La France	CH 250	ABS		without handle	
8-1/2	3-3/16	9-1/4	La France	CH 275	ABS		without handle	
8-1/2	3-7/16	9-1/4	La France	CH 300	ABS		without handle	
8-1/2	3-11/16	9-1/4	La France	CH 325	ABS		without handle	
8-1/2	4-7/16	9-1/4	La France	CHS 400	ABS		without handle	
8-1/2	5-7/16	9-1/4	La France	CHS 500	ABS		without handle	
8-1/2	6-7/16	9-1/4	La France	CHS 600	ABS		without handle	

chart continued on following page

PORTABLE INSTRUMENT CASES

Length	Height	Depth	Mfr.	Model No.	Case Material	Comments	Options	Color
9-1/2	3-1/2	13	Premier	TIC-030913	Al/vinyl	top carrying handle	tilt stand rack adapters PC card cages	13 stock colors avail- able. Consult manufacturer
9-1/2	5-1/4	13	Premier	TIC-050913	Al/vinyl	top carrying handle		
9-1/2	7	13	Premier	TIC-070913	Al/vinyl	top carrying handle		
9-1/2	8-3/4	13	Premier	TIC-080913	Al/vinyl	top carrying handle		
9-1/2	10-1/2	13	Premier	TIC-100913	Al/vinyl	top carrying handle		
9-1/2	12-1/4	13	Premier	TIC-120913	Al/vinyl	top carrying handle		
9-1/2	14	13	Premier	TIC-140913	Al/vinyl	top carrying handle		
9-1/2	3-1/2	17	Premier	TIC-030917	Al/vinyl	side carry handgrips		
9-1/2	5-1/4	17	Premier	TIC-050917	Al/vinyl	side carry handgrips		
9-1/2	7	17	Premier	TIC-070917	Al/vinyl	side carry handgrips		
9-1/2	8-3/4	17	Premier	TIC-080917	Al/vinyl	side carry handgrips		
9-1/2	10-1/2	17	Premier	TIC-10017	Al/vinyl	side carry handgrips		
9-1/2	12-1/4	17	Premier	TIC-120917	Al/vinyl	side carry handgrips		
9-1/2	14	17	Premier	TIC-14017	Al/vinyl	side carry handgrips		
11-1/3	3-1/2	13	Buckeye	3503	Al	concealed fasteners	tilt stand; rack adapter	grey with suede-like finish. Consult mfr. for stock colors
11-1/3	5-1/4	13	Buckeye	5253	Al	concealed fasteners	tilt stand; rack adapter	
11-1/3	7	13	Buckeye	7003	Al	concealed fasteners	tilt stand; rack adapter	
11-1/3	8	13	Buckeye	8003	Al	concealed fasteners	tilt stand; rack adapter	
11-1/3	8-3/4	13	Buckeye	8753	Al	concealed fasteners	tilt stand; rack adapter	
11-1/3	10-1/2	13	Buckeye	10503	Al	concealed fasteners	tilt stand; rack adapter	
12-1/2	6-3/4	11-5/8	La France	CLS 625	ABS		tilt stand	Stock and custom color Consult manufacturer
12-1/2	7-3/4	11-5/8	La France	CLS 725	ABS		tilt stand	
12-1/2	8-3/4	11-5/8	La France	CLS 825	ABS		tilt stand	
15-5/8	3-1/2	13	Premier	TIC-031513	Al/vinyl	side carry handgrips	tilt stand; PC card cages	
15-5/8	5-1/4	13	Premier	TIC-051513	Al/vinyl	side carry handgrips	tilt stand; PC card cages	
15-5/8	7	13	Premier	TIC-071513	Al/vinyl	side carry handgrips	tilt stand; PC card cages	
15-5/8	8-3/4	13	Premier	TIC-081513	Al/vinyl	side carry handgrips	tilt stand; PC card cages	
15-5/8	10-1/2	13	Premier	TIC-101513	Al/vinyl	side carry handgrips	tilt stand; PC card cages	

WITH SO MANY FINE DIGITAL CIRCUITS BEING presented in electronic hobbyist magazines, one is tempted to construct them at the earliest possible opportunity. These articles generally present the projects using one of two construction techniques—either using a printed-circuit type of construction, or wire-wrap techniques. Little needs to be said about the PC board type of project construction, since usually a complete PC layout is provided with the article that can be copied using many different techniques to reproduce the circuit (or sometimes a PC layout may even be offered by a manufacturer at a bargain price).

This article discusses the wire-wrap technique and presents several ways to cut down on the time-consuming job of wire-wrapping each and every individual terminal point. The technique is useful for digital and computer-circuit applications, and hams and CB enthusiasts will also find it useful.

Wire-wrap tools

First, let's discuss the various tools and wire-wrap terminals that are currently available to the hobbyist. An example is the wire-wrap tool manufactured by the OK Machine & Tool Corp. The cost of this tool is nominal for what it will do: i.e., wire-wrap a measured and stripped length of wire between two terminals. It does the job quickly (after the wire is prepared) and is an excellent addition to your electronic tool kit. Not only does it wrap the wire, it is also designed to unwrap it, which adds up to a good design in a single tool.

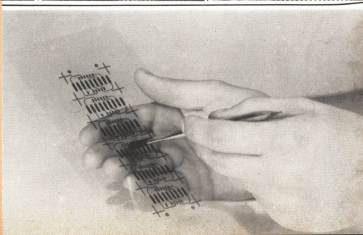
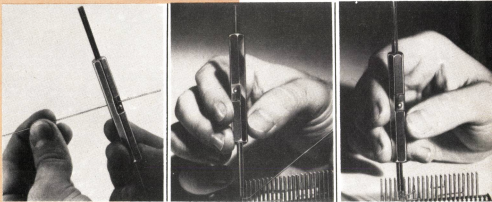
Now, here's what I consider to be a versatile wire-wrap tool—the Vector *Slit-N-Wrap*. Here, an ingenious design makes wire-wrapping a simple job. No need to measure the wire length between terminals that will be wire-wrapped together to form the circuit path. This single tool allows you to slip the tool (the wire is contained on a spool in the tool's

Combining wire-wrap with a printed circuit can be the answer to many layout and construction problems connected with many projects. Here are some hints in using this technique.

PC/Wire-Wrap-

New Construction Technique

JAMES E. TEMPLE



handle) over the terminal, wrap the wire seven turns or more and then directly run the wire to the next terminal to be wrapped, again slipping the tool over the end of that terminal and wrapping seven times around the post. If the particular circuit path must be wired to more than two terminal posts, then this tool allows you to continue wrapping to the next post without having to measure a new wire length. Just continue to wrap all the terminals that must be connected to this particular circuit path. When the last terminal in the series to be wire-wrapped is finished, just cut the wire and proceed to the next circuit path. It is just that simple with the Vector *Shit-N-Wrap* tool, and a great time-saver.

One of the nicest things that Vector has done is to support the needs of those who must use wire-wrap for their circuits. Vector has a complete line of wire-wrap posts and the tools to insert them in the epoxy boards.

Sockets

There are also IC wire-wrap sockets that are usually available with three levels of wrapping space. Many companies offer these sockets; and, of course, the choice of terminal pins or sockets is up to you. However, Robinson-Nugent, Inc., has an extensive line of different types of sockets, terminals and pins. One of the most handy types of sockets is the wire-wrap strip socket (model WB-25-55-G), which comes in a 25-pin-length IC connector. These sockets are easily cut to the pin length you need, are easily cemented to

the board for mounting and are flexible if changes are required. If you have an oddball type of IC (let's say, 22-pins, 30-pins, etc.) and you just cannot find the right wire-wrap socket for it, then these strip sockets can come to the rescue. Simply cut the strip to size and form the IC socket from it.

Another excellent product manufactured by Robinson Nugent is their low-profile, wire-wrappable J-pin designed for IC DIP packages. These pins offer an extreme low profile to the circuit board; sockets can be made from them directly; they are space-savers; and are wire-wrapped to the underside of the J-pin.

Avoiding the jungle

Up to now we have discussed the tools, terminals and many other products offered by manufacturers that support the wire-wrap construction technique. Now let's get to the heart of the article—how to avoid the jungle and mass of wires when you wire-wrap. If you are like many hobbyists who have used the technique and have completed several wire-wrap projects, you will know what I mean by a jungle. The back of a finished wire-wrap board contains hundreds of inches of wire, and many wires cross each other, along with various colors you may have used to color-code the wires. If a change is made, you must be very careful to cut or unwrap the correct wires, and if several levels of wire-wrap exist on any single terminal, extra care is needed to make these changes.

There are ways to cut down on the

number of wire-wrap connections you have to make. You can combine a printed-circuit board with wire-wrap terminals. The number of connections can be reduced by using a combination of similar lines, wire-wrap sockets, and just plain common sense and planning. For example, when a construction project calls for similar pinouts to be connected, as in the case of a computer memory board, print the redundant connections to the IC sockets right on a PC board. Then just solder in the similar terminals to be connected, either to the upper side or the lower side of the PC board.

As for other electronic circuits, review your project and look for similar pinouts of the IC; for instance, the power connections, the clock inputs, or a group of IC's that are of the same type. All that you need do is plan a PC card (double-sided copper), layout the IC on the board, use an etchant pen or lacquer etchant to draw the connecting lines that are redundant in nature (after drilling the holes into the PC board, of course), and eliminate as many wire-wrap connections as possible in the design. Be sure to provide for the terminal pins that act as connectors between the foils on the top of the board to the foils on the bottom of the board. Once the design has eliminated as many wire-wrap lines as possible, etch the board, clean it, insert the sockets or J-pins, and finish wrapping the circuit paths you could not combine onto the PC card. With the right design and careful preparation, the PC lines will eliminate as much as one-half or more of the wire-

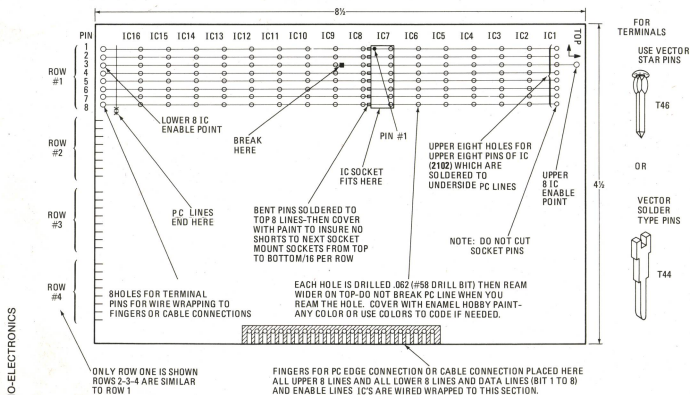


FIG. 1—A PRINTED-CIRCUIT card for a memory board. Bottom tracks are directly under the top ones. The trick here is to solder pins on one side of each socket directly to the upper tracks.

wrap lines. Rather than having a jungle of wires, you will have an orderly system that is easy to change or add to. It works!

How to design a PC board

Let's take a particular type of IC package and design a PC card and plan the wire-wrap terminals. (See Fig. 1.) I can best show how to eliminate redundant lines by using the popular 2102 memory IC. I have constructed a memory card, 3 1/2 inches wide by 7 inches long, containing over 64 IC's. Consider this: Eight 2102's provide a memory word that is 8 bits wide. This means eight 2102's will provide 1024 8-bit memory locations. Each 2102 has 16 pins, eight on each side. Of the 16 pins, 10 are used for the memory address, one for read-write control, and one for chip-enable. Of the four remaining pins, one is used for the positive power-supply connection and one for the ground or return connection. All these pins are paralleled together between the eight 2102's. Only the data-in pin and the data-out pins will be considered as separate line- or wire-wrap connections. Of course, if several 8-bit-wide memory banks are being considered, these same pins will be paralleled to the same pins within the other memory banks.

Let's take a look at how we can eliminate some wire-wrap connections so that there are only a few. This will enable you to get a large number of IC packages in a very tight space.

Figure 1 shows the layout of the double-sided PC board. Two memory banks are shown. Each bank contains 1024 8-bit words. One bank consists of IC1-IC8, the upper lines of the PC layout and the terminal pins for wire-wrapping. The other consists of IC9-IC16. The eight foil traces on the foil side of the board parallel eight traces on the component side and are, therefore, not visible in Fig. 1.

Note from the layout for the 64 IC's (8K of memory, 2102 type) that only 32 holes are drilled for each 1K of memory. These holes are for the upper eight pins (one side) of the DIP wire-wrap socket.

Send eight socket terminals (only one side of the DIP) at a right angle to the socket (see Fig. 2), cut the leads short and insert the other eight socket pins through the holes to be soldered to the lower PC traces. The right-angle pins are soldered to the upper PC traces. Thus, there are eight parallel foil traces on the upper and lower side of the PC card that are isolated by the thickness of the epoxy board itself.

To make sure the eight socket pins that are pushed through the board do not make contact with the upper eight parallel foil traces, it is best to take an Xacto knife with a No. 17 blade and ream the holes from the top of the PC board (see Fig. 3). To further insure isolation, use enamel paint to cover the holes on the top side. Now, when the sockets are pushed

into place, the top right-angle pins and the lower terminal pins are soldered, and the lower eight pins and the upper eight pins are electrically isolated from each other. This type of setup requires that when you insert the sockets, you start

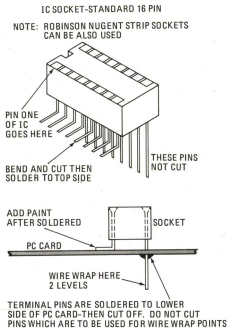


FIG. 2—HOW SOCKETS ARE MODIFIED when you are using the combined printed-circuit and wire-wrap techniques.

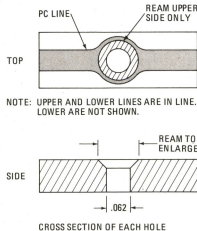


FIG. 3—ISOLATING THE PINS that go through the board to the bottom traces is simple. You can use an Xacto knife as a reamer.

from the uppermost top socket (IC1) and solder the connections. Then, to protect against possible shorts, paint over the top soldered pins with the enamel. Now, the next row of IC sockets can be soldered in place until all sockets are mounted to the PC board.

When you design the PC layout, bring the eight foil traces on the component side to a stopping point beyond the foil traces on the bottom of the board. On the component side, also extend the IC enable trace at the opposite end of the board and break the trace between IC8 and IC9 (this isolates the two memory banks).

Now (for the traces on the component side only) drill eight holes into the extended portion of the traces, insert eight terminal pins and solder the pins. For the eight foil traces on the bottom side of the board, cut the socket terminals short right up to the solder connection, all except for the top row of terminals. This row of terminals is now used for wire-wrap connections to the traces on the bottom side of the board. Make sure not to cut the data-in or data-out pins on the sockets since these pins will be paralleled to the other data-in and data-out pins and finally wire-wrapped to the input for the cable connections to the card.

On the component side of the card, you can use PC lines to make edge-connector fingers, the type of fingers or number of lines will depend upon the type of bus to which the card will be connected. Or, you can make a provision for wiring in a cable to connect to the bus lines. (Wires should be soldered in, and you can use the wire-wrap pins that allow wire-wrapping to the lower side of the wire cable.) Finally, for the fingers or the wire cable, insert the wire-wrap terminal pins, solder them firmly to the card, and finish the PC board by wire-wrapping the connections to the appropriate pinouts for the particular bus structure.

What you have just constructed is a compact tri-level PC board. Redundant or similar lines have been connected by foil traces, soldered to the sockets (modified for solder connections to the PC board), and all that remains is to wire-wrap the end terminal pins of each row of IC's. The few wire-wrap wires you have used can be taped to the card to secure them; changes made to the circuit are easier as each line is accessible, both top and bottom. With an 8 1/2- by 4 1/2-inch card, there is no reason why 64 DIP IC's cannot be located on it. It is possible that on a 9- by 16-inch-wide card you can cram in four times the number of IC's, and in terms of memory for computers, provide a 32K board. What we have not provided for on this type of memory board is bank-select in 1K increments, nor did we buffer the memory address lines or buffer the data lines. However, this problem is easily overcome by a second memory control and select card of appropriate design.

What we have demonstrated are the principles of combining the best of two worlds in project construction; that is, using PC layouts (to eliminate many redundant lines to the various IC's) and using wire-wrap sockets modified to the card for solder and wire-wrap connections. Using this technique you can fit a great many IC's in a highly crowded space, and wire-wrapping the final connections is made simple. Less than one-half of the wire-wrap connections will be required by this type of construction, yet all lines are accessible if changes or additions to the circuit are required. R-E

New IHF Amplifier Specifications

Amplifier comparisons made more realistic for the layman by a new IHF testing standard that provides a closer correlation between what he hears and what the lab technician measures.

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

AFTER NEARLY THREE YEARS OF DELIBERATIONS, the Institute of High Fidelity (IHF) has published and approved a new standard entitled "Methods of Measurement for Audio Amplifiers." This standard (IHF-A-202, 1978) supersedes an earlier IHF standard that had been used since 1966 but rendered obsolete in 1974 when the Federal Trade Commission ruled that the continuous power rating of an audio amplifier intended for home entertainment had to be specified in a somewhat different manner than had been done using the old standard.

One of the major new measurements incorporated in the new standard is dynamic headroom. This measurement was designed to help consumers select one of two amplifiers having the same *continuous* power-output ratings but achieving significantly different loudness levels when fed with the same short-term dynamic musical signals.

An amplifier having a very "stiff" power supply may produce very little more output power than its rated continuous power level under such conditions, whereas an amplifier with a "soft" or less-regulated supply may, under the same conditions, deliver power greater than its continuous rated level. The dynamic headroom dB specification may therefore vary from 0 (for the stiffly regulated power-supply amplifier) to +3.0, or even more.

Now that the new standard has become officially recognized by the IHF, let's look at some of the other new measurement methods it describes. The new standard attempts to correlate more accurately what the consumer *hears* when listening to an amplifier and what the technician *measures* for that amplifier during

lab tests. Equally important, the new standard insures that *all* manufacturers that publish amplifier or preamplifier specs make all measurements in identical fashion and report their findings uniformly so that prospective purchasers are not comparing "apples and oranges" when looking at competing products.

Since *Radio-Electronics* publishes complete high-fidelity test reports on audio amplifiers and preamplifiers, in future reports, we will adopt the new measurement techniques described in the standard. While to detail every one of the new measurements is beyond the scope of this article, we'll try to explain those major changes in measurement techniques that will affect the test reports. Those interested in obtaining the complete standard may do so by sending a check or money order to The Institute of High Fidelity, 489 Fifth Avenue, New York, NY 10017, in the amount of \$7.50. Ask for Standard IHF-A-202, 1978.

New reference levels

One of the most confusing factors

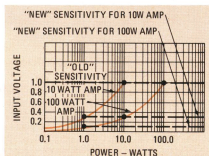


FIG. 1—NEW IHF SENSITIVITY rating specifies the input voltage required to produce a 1-watt output.

found in published amplifier specifications has been the lack of uniformity in the reference levels used to make sensitivity and signal-to-noise ratio measurements. For instance, let's consider two

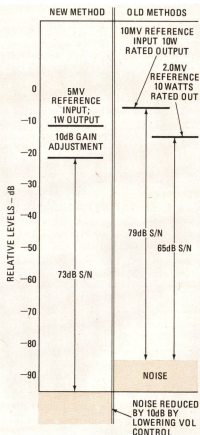


FIG. 2—NEW IHF S/N RATIO STANDARD specifies reference input level and output level. The volume control is adjusted to obtain the specified 1-watt output level. The old standard required S/N to be measured at full-rated output.

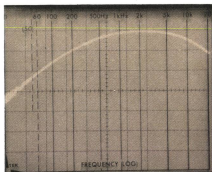


FIG. 3—RESPONSE of A-weighting network used in hum measurements.

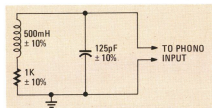


FIG. 4—NETWORK approximates the impedance of a magnetic phono cartridge. To comply with new IHF standard, network must be connected to phono preamp for S/N measurements.

audio amplifiers, one with a 10-watt power-output rating and the other with a 100-watt-per-channel rating. An amplifier's input sensitivity has traditionally been measured so as to describe how much input-signal amplitude is required for the given amplifier to deliver its *rated* output (with the volume control turned all the way up to maximum). Suppose each of the two amplifiers in our example requires an input signal of 1.0 volt to deliver its rated output. This implies that both amplifiers have "equal sensitivity." Yet, if 1 volt is fed into the 100-watt-per-channel amplifier, it will *sound* 10-dB louder than if it were fed to the 10-watt-per-channel amplifier! It is therefore clear that the *gain* of the two amplifiers is not identical.

In the new standard, amplifier sensitivity is still measured with the volume control turned up fully, but now it is specified as the voltage required to produce 1.0 watt at the speaker-output terminals (or 0.5 volts in the case of a separate preamplifier), regardless of the full power (or voltage output) rating. Using that reference output level in the two examples, the input sensitivity of the 10-watt amplifier is now 0.316 volt (for a 1-watt output), while the input sensitivity of the 100-watt-per-channel amplifier is 0.1 volt (for a 1-watt output). These concepts are shown in Fig. 1, in which power output for the two amplifiers is plotted against input voltage.

S/N reference levels

Even more confusing were previous

methods of measuring signal-to-noise (S/N) ratios.

Again, let's look at two hypothetical amplifiers. One integrated amplifier has a phono-input sensitivity of 2.0 mV (i.e., 2.0 mV applied to the phono-input terminals at 1 kHz drives the amplifier to its full rated output if the volume control is turned up all the way). Let's assume that the S/N measurement (when the signal is removed and the input jacks are shorted) is 65 dB.

Another amplifier manufacturer, whose phono preamplifier is just as noisy as the first, decides that a 65-dB value does not look "good enough" in print. So, he chooses an input reference level of 10 mV. But, of course, when 10 mV are applied to this amplifier, the amplifier will overload (since it, too, would produce full rated output from a 2.0-mV signal with the volume control turned up fully).

Therefore, the manufacturer *lowers* the volume-control setting until rated power output is obtained once more. And he would have to lower it by approximately 14 dB! Assuming that the residual noise is a function only of the phono preamplifier, the manufacturer now reads a S/N ratio of 79 dB, even though the preamp section in his unit is no less noisy than that of his competitor!

In order to establish uniform S/N readings, the new standard dictates that the input-signal level be fixed at 5.0 mV for a magnetic phono section, and at 0.5 volt for a high-level input such as the tuner, auxiliary, or tape input on a preamplifier or integrated amplifier. In addition, the *output* reference level must be adjusted (as in the case of sensitivity measurements) to a 1.0-watt level (for a power amplifier) or 0.5 volt (for a preamplifier). This adjustment is made by using

PRIMARY SPECS FOR POWER AMPLIFIERS:

1. Continuous Average Power Output
2. Dynamic Headroom
3. Frequency Response
4. Sensitivity
5. A-Weighted Signal-To-Noise Ratio

PRIMARY SPECS FOR PREAMPLIFIERS:

1. Frequency Response
2. Maximum Voltage Output
3. Total Harmonic Distortion
4. Sensitivity
5. A-Weighted Signal-To-Noise Ratio
6. Maximum Input Signal
7. Input Impedance

PRIMARY SPECS FOR INTEGRATED AMPLIFIERS:

1. Continuous Average Power Output
2. Dynamic Headroom
3. Frequency Response
4. Sensitivity
5. A-Weighted Signal-To-Noise Ratio
6. Maximum Input Signal
7. Input Impedance

TABLE 1—PRIMARY SPECS that must be provided by manufacturer to comply with new IHF standards.

1. Clipping Headroom
2. Output Impedance
3. Wideband Damping Factor
4. Low-Frequency Damping Factor
5. CCIR/ARM Signal-To-Noise Ratio
6. Tone-Control Response
7. Filter Cutoff Frequency
8. Filter Slope
9. Crosstalk
10. A-Weighted Crosstalk
11. CCIR/ARM Crosstalk
12. SMPTE Intermodulation Distortion
13. IHF Intermodulation Distortion
14. Transient-Overload Recovery Time
15. Slew Factor
16. Reactive Load
17. Capacitive Load
18. Separation
19. Difference of Frequency Response
20. Gain-Tracking Error
21. Tone-Control Tracking Error

TABLE 2—SECONDARY SPECS that may be provided at manufacturer's discretion.

TABLE 3
RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer:

Model:

AMPLIFIER PERFORMANCE MEASUREMENTS

POWER OUTPUT CAPABILITY

RMS power/channel, 8-ohms, 1 kHz (watts)
RMS power/channel, 8-ohms, 20 kHz (watts)
RMS power/channel, 8-ohms, 20 kHz (watts)
RMS power/channel, 4-ohms, 1 kHz (watts)
RMS power/channel, 4-ohms, 20 kHz (watts)
RMS power/channel, 4-ohms, 20 kHz (watts)
Frequency limits for rated output (Hz-kHz)
Dynamic headroom (dB)

R-E
Measurement

R-E
Evaluation

DISTORTION MEASUREMENTS

Harmonic distortion at rated output, 1 kHz (%)
Intermodulation distortion, rated output (%)
Harmonic distortion at 1-watt output, 1 kHz (%)
Intermodulation distortion at 1-watt output (%)

DAMPING FACTOR AT 8 OHMS, 50 Hz

PHONO PREAMPLIFIER MEASUREMENTS

Frequency response (RIAA \pm dB)
Maximum input before overload (mV)
Hum/noise, "A" wt'd, referenced to 1W or 0.5V output, for 5-mV input (dB)

HIGH-LEVEL INPUT MEASUREMENTS

Frequency response (Hz-kHz, \pm dB)
Hum/noise, "A" wt'd, re 0.5 or 1W out, 0.5V in (dB)
Residual noise, "A" wt'd, minimum volume, re 1W out (dB)

TONAL COMPENSATION MEASUREMENTS

Action of bass and treble controls
Action of secondary tone controls
Action of high- and low-frequency filters

See Fig.
See Fig.
See Fig.

COMPONENT MATCHING MEASUREMENTS

Input sensitivity, PH-1/PH-2, re 1W or 0.5V out (mV)
Input sensitivity, high-level, re 1W or 0.5V out (mV)
Output level, tape outputs, at rated output (mV)
Output level, headphone jack, at rated output (mV or mW)

EVALUATION OF CONTROLS, CONSTRUCTION AND DESIGN

Adequacy of program source and monitor switching
Adequacy of input facilities
Front panel layout
Action of controls and switches
Design and construction
Ease of servicing

OVERALL AMPLIFIER PERFORMANCE RATING

with those manufacturers who have used an A-weighting network in making S/N measurements, and requires that type of network to be inserted between the output of the amplifier and the meter used to measure the noise voltage or residual noise.

Most manufacturers have traditionally measured phono signal-to-noise ratios by inserting a shorting plug in the phono-input jacks. In the case of many phono-preamplifier circuits, this test method does not reflect what actually happens when you connect a magnetic cartridge to those same phono inputs. A magnetic cartridge has a certain amount of DC resistance, plus a finite amount of inductance. Instead of inserting a shorting plug, the new standard requires using a network that approximates the complex impedance "observed" by the phono inputs when a cartridge is actually connected; a diagram of this network is shown in Fig. 4.

For making S/N measurements of the high-level inputs on an amplifier or preamplifier, a 1000-ohm resistor will be used to terminate the input jacks.

Primary amp/preamp ratings

To rate amplifiers according to the new IHF standards, the manufacturer must list certain primary ratings in order of their importance. For a basic power amplifier, five basic ratings must be shown; while for an integrated amplifier or a preamplifier, seven primary ratings must be given. Table 1 lists the primary ratings in each case.

At least 21 other secondary ratings and how to measure them are included in the IHF standards, and can be listed (in part or in whole) by the manufacturer at his own discretion. Table 2 shows these secondary ratings.

Future test reports

It has been Radio-Electronics' practice to publish tabular listings of measured results on amplifiers, receivers and preamplifiers in its high-fidelity test reports. Table 3 shows the form that will be used in future test reports. The italicized items in this table represent either new specs not previously reported on, or those that have been reported on using earlier techniques and that will now be measured in accordance with the new standards. Since it will probably take some time before all manufacturers begin to use the standards, it may be somewhat difficult to compare their published specifications with those measured according to the new standard. For example, signal-to-noise ratios may seem poorer or lower than those specified using older methods.

In time, however, it is hoped that most serious high-fidelity manufacturers will adopt the new measurement techniques and ratings; this will make it that much easier for an audio consumer to select good hi-fi amplification equipment. **R-E**

the master volume control. This makes a lot of sense since it places the master volume control at a setting that approximates that which a consumer would normally use in actual music listening. No one ever listens to a hi-fi stereo system with the volume control turned up fully (in most cases, this would overdrive the amplifier or preamplifier into severe clipping, since amplifier gain has nothing to do with maximum amplifier power or voltage output).

Figure 2 shows the old and the new methods of measuring signal-to-noise; it is assumed that other amplifier stages do not affect overall noise. Actually, we have already discovered that very often you cannot compute new S/N values from the old values (even taking into account new reference input and output levels) since, as the new input and output reference levels are set up (by the volume control and by varying signal-input levels), other noise-producing stages affect the measurement. Thus, it is next to impossible to convert from the old measurement meth-

od to the new by simply juggling dB and gain figures.

A-weighting

In the past, some manufacturers used a weighting network in signal-to-noise measurements while others did not. A weighting network recognizes the fact that the human hearing system does not respond equally to all audible frequencies, especially at low listening levels. Our ears are less sensitive to line frequency or hum than to mid-frequencies, and are also less sensitive to ultra-high frequencies. In the past some manufacturers used an A-weighting network to take into account the subjective aspects of residual noise. This network has a frequency-response characteristic that is shown in Fig. 3, in which you will note that much less importance is given to 60-Hz noise (about 20-dB less) than to noise at, say, 1 kHz. Similarly, noise at 10 kHz is given approximately 5-dB less importance than noise at mid-frequencies.

The new standard is in conformance

Radio-Electronics Audio Lab Tests

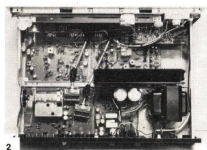
Yamaha CR-420 AM/FM Receiver



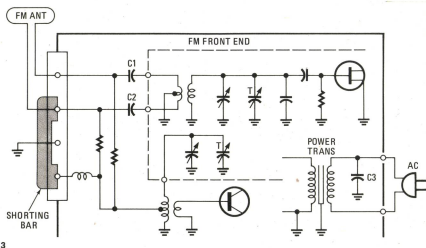
1
CIRCLE 130 ON FREE INFORMATION CARD

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

THE PUBLISHED SPECIFICATIONS FOR YAMAHA'S relatively low-powered *model CR-420* receiver contain one term you may not have seen before. This is the NDCR specification (Noise Distortion Clearance Range). Yamaha (6600 Orangethorpe Avenue, Buena Park, CA 90622) developed this specification in the belief that it tells more exactly what you can expect from the product in terms of combined noise and distortion during actual use. When you read this claim, you'll note that, with the volume control turned down 20-dB below its maximum (typical of normal use), the *model CR-420* receiver produces no more than 0.1%



2



3

combined noise and distortion at any listening level from 100 mW to the full rated output of 22 watts-per-channel. While it can be argued that distortion at a -60-dB level (compared with output level) is far less annoying than

noise at that same level, this extra specification gives you some idea of what you can expect in the way of dynamic range.

The NDCR specification is only one of several innovative features associated with this low-cost receiver. The front panel of the *model CR-420* is shown in Fig. 1. To the left of the long and narrow dial calibration area is a single tuning meter that serves as a signal strength meter in the AM mode and as a center-of-channel tuning meter for the FM mode, with FM frequencies calibrated at every half-MHz. Three tiny LED indicators to the right of the scales inform you whether you are listening to AM, FM, or stereo FM. Step-type BASS and TREBLE controls are located just below the tuning meter, and next to them is an independent loudness control. This control is used to change listening levels after the main volume control has been adjusted to realistic listening levels, depending upon the program source selected. The control covers a range (downward in level) of around 20 dB, and as it is rotated away from the flat or maximum clockwise position, this introduces just the right amount of loudness compensation. This arrangement works far better than the usual combination volume/loudness-control-plus-switch found on many competitive receivers.

Recording-output and program-source selector switches are also operated independently of each other. This makes it possible to feed one program to an associated tape deck while

MANUFACTURER'S PUBLISHED SPECIFICATIONS:

FM TUNER:

Usable Sensitivity (mono): 1.8 μ V (10.3 dBf). **50-dB Quieting**: mono; 3.5 μ V (16.1 dBf); stereo, 43.5 μ V (38 dBf). **S/N Ratio**: mono, 77 dB; stereo, 71 dB. **Capture Ratio**: 1.0 dB. **Selectivity**: 65 dB. **Image Rejection**: 50 dB. **AM Suppression**: 56 dB. **IF and Spurious Rejection**: 75 dB. **Harmonic Distortion**: mono, 0.15% at 100 Hz and 1 kHz, 0.3% at 6 kHz; stereo, 0.25% at 100 Hz and 1 kHz, 0.8% at 6 kHz. **Stereo Separation**: 40 dB at 1 kHz, 30 dB at 50 Hz and 10 kHz. **Frequency Response**: 30 Hz to 15 kHz, +1.0, -3.0 dB. **Muting Threshold**: 5.0 μ V (19.2 dBf).

AM Tuner:

IHF Sensitivity: 18 μ V per meter. **Selectivity**: 20 dB. **S/N Ratio**: 50 dB. **IF and Image Rejection**: 40 dB. **Harmonic Distortion**: 0.6%.

Amplifier:

Power Output: 22 watts-per-channel, 8 ohms, 20 Hz to 20 kHz. **Harmonic Distortion**: 0.05%. **IM Distortion**: 0.05%. **Damping Factor**: 40. **Input Sensitivity**: phono, 2.0 mV; high level, 120 mV. **Frequency Response**: phono, RIAA \pm 0.5 dB; high level, 20 Hz to 20 kHz, \pm 1.5 dB. **S/N Ratio**: phono, 91 dB (referenced to a 10-mV input); high level, 97 dB. **Noise Distortion Clearance Range**: for 0.1% THD, 20 Hz to 20 kHz with volume control at -20 dB; phono to speakers, from 100 mW to 22 watts. **Bass Range**: \pm 12 dB at 50 Hz. **Treble Range**: \pm 11 dB at 20 kHz. **High Filter Cutoff**: 6 dB-per-octave above 10 kHz. **Low Filter Cutoff** (built-in): 12 dB-per-octave below 10 Hz.

General Specifications:

Power Consumption: 130 watts, 120 volts 60 Hz. **Dimensions**: 17 $\frac{1}{4}$ "W \times 6 $\frac{1}{2}$ "H \times 12 $\frac{1}{4}$ "D. **Weight**: 19 lb. **Suggested Retail Price**: \$280.

TABLE 1
RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: Yamaha

Model: CR-420

FM PERFORMANCE MEASUREMENTS

SENSITIVITY, NOISE AND FREEDOM FROM INTERFERENCE

	R-E Measurement	R-E Evaluation
IHF sensitivity, mono: (μV) (dBf)	1.7 (9.8)	Excellent
Sensitivity, stereo (μV) (dBf)	8.0 (23.3)	Good
50-dB quieting signal, mono (μV) (dBf)	2.5 (13.2)	Excellent
50-dB quieting signal, stereo (μV) (dBf)	33.0 (35.6)	Very good
Maximum S/N ratio, mono (dB)	76	Excellent
Maximum S/N ratio, stereo (dB)	70	Excellent
Capture ratio (dB)	1.0	Excellent
AM suppression (dB)	58	Good
Image rejection (dB)	52	Fair
IF rejection (dB)	75	Good
Spurious rejection (dB)	78	Good
Alternate channel selectivity (dB)	65	Good

FIDELITY AND DISTORTION MEASUREMENTS

Frequency response, 50 Hz to 15 kHz (± dB)	0.3	Excellent
Harmonic distortion, 1 kHz, mono (%)	0.06	Superb
Harmonic distortion, 1 kHz, stereo (%)	0.07	Superb
Harmonic distortion, 100 Hz, mono (%)	0.06	Superb
Harmonic distortion, 100 Hz, stereo (%)	0.075	Superb
Harmonic distortion, 6 kHz, mono (%)	0.12	Excellent
Harmonic distortion, 6 kHz, stereo (%)	0.15	Excellent
Distortion at 50-dB quieting, mono (%)	0.4	Very good
Distortion at 50-dB quieting, stereo (%)	0.35	Very good

STEREO PERFORMANCE MEASUREMENTS

Stereo threshold (μV) (dBf)	8.0 (23.3)	Good
Separation, 1 kHz (dB)	54	Superb
Separation, 100 Hz (dB)	45	Excellent
Separation, 10 kHz (dB)	43	Superb

MISCELLANEOUS MEASUREMENTS

Muting threshold (μV) (dBf)	5.0 (19.2)	Very good
Dial calibration accuracy (± kHz at MHz)	50-overall	Excellent

EVALUATION OF CONTROLS CONSTRUCTION AND DESIGN

Control layout	Excellent
Ease of tuning	Very good
Accuracy of meters or other tuning aids	Excellent
Usefulness of other controls	Excellent
Construction and internal layout	Very good
Ease of servicing	Excellent
Evaluation of extra features, if any	Very good

OVERALL FM PERFORMANCE RATING

Excellent

you listen to a completely different program source. Volume and balance controls are concentrically mounted, and next to them is the tuning knob.

The bottom of the panel contains a pushbutton power on-off switch; two phone jacks (for dual stereophonic headphone listening); speaker selector pushbuttons for choosing one or both pairs of speaker systems (which can be connected to the model CR-420); a high-cut filter switch; an AM/FM selector pushbutton; a mono/stereo mode selector; and an FM muting switch which, when pressed to OFF, also switches the FM reception into the monophonic mode, regardless of the incoming FM signal.

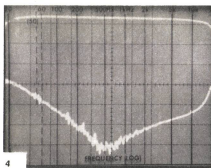
The rear panel of the model CR-420 contains terminals for 75-ohm, 300-ohm FM and external AM antennas. Nearby are the phone and auxiliary input jacks as well as the tape-out and tape-in jacks and a chassis ground terminal. Two rows of spring-loaded color-coded speaker terminals are next, followed by a pair of convenience AC receptacles (one switched, the other unswitched). A wide variety of additional components can be connected to the model CR-420 receiver.

Circuit highlights

An internal view of the chassis is shown in Fig. 2. The power-supply circuitry is well isolated from low-level and RF circuits, and the two major rotary switches are connected to

front-panel knobs via long coupling shafts and swivel joints. This design places the actual switches close to the circuits they must select.

The front-end section of the receiver uses a three-gang tuning capacitor and a junction FET for the RF amplifier stage. The IF section uses a four-element ceramic filter, a two-stage



reception, the FM antenna acts as a whip antenna because of the high impedance provided by capacitors C1 and C2 (see Fig. 3). Using capacitor C3 to bypass the power-transformer primary side, the ground side of the AM antenna coil is grounded via the power-line cord; this provides a whip antenna effect. To increase the antenna's sensitivity, the shorting bar shown in Fig. 3 bridges the terminals as shown. If overloading results, the bar can be removed.

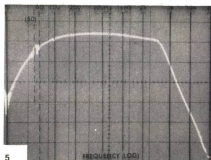
The power-amplifier section of the model CR-420 is direct-coupled and consists of a differential amplifier stage with constant-current circuitry, a Class-A driver stage with two-stage thermal compensation, a Darlingon pair full complementary single-ended push-pull DC-coupled output stage, and a power-consumption limiter-type protection circuit.

A speaker protection relay separates the amplifier and speakers when the power switch is turned on or whenever more than ± 2 volts DC is present at the speaker output terminals.

FM measurements

Table 1 summarizes measurements made for the FM tuner section. The results can be compared with the manufacturer's published specifications shown elsewhere in this report. Almost every performance specification was either equalled or exceeded, except for the monophonic and stereophonic signal-to-noise claims, which were nonetheless excellent. The 1-kHz distortion readings of 0.06% in mono and 0.07% in stereo are about as low as we have ever read, even when lab testing the very highest-priced separate tuners. Stereo FM separation of better than 50 dB at mid-frequencies and above 40 dB at 10 kHz is also unusual in receivers in any price or power category.

Figure 4 is a scope analysis of FM frequency response and separation. Note that FM de-



emphasis no longer plays a part in these measurements since in our lab we now use a signal processor ahead of our FM generator, which applies the required pre-emphasis to the swept modulating test signal to achieve a flat "net" response.

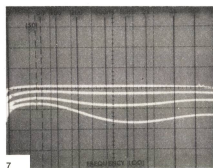
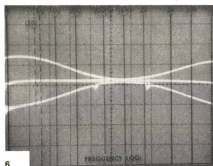
Figure 5 is a scope photo of AM response and, as is true of most stereo receivers providing AM reception, response began to fall off at around 3 kHz.

Amplifier measurements

Table 2 contains a summary of all amplifier/preamplifier-control measurements made on the model CR-420. The performance of this section was consistent with that of the tuner. Power ratings are conservatively stated since we obtained an output of 34.0 watts-per-channel at mid-frequencies and 31 watts-per-channel at 20 kHz, as opposed to the 22-watt-per-

channel FTC power rating claimed. At an actual rated output of 22 watts-per-channel (at mid-frequencies), harmonic distortion was an extremely low 0.008% while 1M distortion was almost equally low, with readings of only 0.009%. Distortion readings at the 1-watt level were largely distortion plus noise (with the noise component contributing more to the single-meter reading than the distortion), but they were well below Yamaha's 0.1% NDCR index figure and well below the rated 0.95% THD figure, even ignoring that noise was a contributing factor to the total reading.

The range of the BASS and TREBLE controls of the model CR-420 is shown in Fig. 6. Note that turnover frequencies are positioned lower (for the BASS) and higher (for the TREBLE) than is usual with simple feedback-type con-



trols. This design feature makes it possible to augment extreme bass or extreme treble that might be deficient.

Figure 7 shows the system response at various loudness control settings. When these measurements and sweep-frequency analyses were made, the volume control remained at a fixed setting and only the separate loudness control setting was altered. At mid-frequencies, this control provides up to 20 dB attenuation, but as can be seen from the progressively lower amplitude sweeps, compensation at the bass end of the spectrum increases as the control setting is lowered.

Summary

Table 3 contains an overall product evaluation together with our positive conclusions regarding the model CR-420. Although in the past we have tested more costly Yamaha receivers and other components, this is our first experience with one of their lower-priced products. We have had an opportunity to use the receiver for better than two weeks, and it is easy to see why these receivers are well accepted. Yamaha has brought as much care and thoughtful engineering to "beginner" sets as to its sophisticated separate components. **R-E**

TABLE 2
RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: Yamaha

Model: CR-420

AMPLIFIER PERFORMANCE MEASUREMENTS

	R-E Measurement	R-E Evaluation
POWER OUTPUT CAPABILITY		
RMS power/channel, 8-ohms, 1 kHz (watts)	34.0	Excellent
RMS power/channel, 8-ohms, 20 Hz (watts)	33.0	Superb
RMS power/channel, 8-ohms, 20 kHz (watts)	31.0	Excellent
RMS power/channel, 4-ohms, 1 kHz (watts)	N/A	N/A
RMS power/channel, 4-ohms, 20 Hz (watts)	N/A	N/A
RMS power/channel, 4-ohms, 20 kHz (watts)	N/A	N/A
Frequency limits for rated output (Hz-kHz)	Below 10-45	Superb
DISTORTION MEASUREMENTS		
Harmonic distortion at rated output, 1 kHz (%)	0.008	Excellent
Intermodulation distortion, rated output (%)	0.009	Excellent
Harmonic distortion at 1-watt output, 1 kHz (%)	0.025	Very good
Intermodulation distortion at 1-watt output (%)	0.02	Very good
DAMPING FACTOR, AT 8 OHMS	51.4	Very good
PHONO PREAMPLIFIER MEASUREMENTS		
Frequency response (RIAA \pm dB)	+0.5 - 0	Very good
Maximum input before overload (mV)	140	Very good
Hum/noise referred to full output (dB) (at rated input sensitivity) ("A" weighted)	80	Excellent
HIGH LEVEL INPUT MEASUREMENTS		
Frequency response (Hz-kHz \pm dB)	13-41, 1.0	Very good
Hum/noise referred to full output (dB) ("A" weighted)	102	Excellent
Residual hum/noise (minimum volume) (dB) ("A" weighted)	103	Excellent
TONAL COMPENSATION MEASUREMENTS		
Action of bass and treble controls	See Fig. 7	Good
Action of secondary tone controls		N/A
Action of low-frequency filter(s)		N/A
Action of high-frequency filter(s)		Good
COMPONENT MATCHING MEASUREMENTS		
Input sensitivity, phono 1/phono 2 (mV)	2.1	
Input sensitivity, auxiliary input(s) (mV)	105	
Input sensitivity, tape input(s) (mV)	105	
Output level, tape output(s) (mV)	105	
Output level, headphone jack(s)	125 mV	
EVALUATION OF CONTROLS, CONSTRUCTION AND DESIGN		
Adequacy of program source and monitor switching		Very good
Adequacy of input facilities		Very good
Arrangement of controls (panel layout)		Excellent
Action of controls and switches		Excellent
Design and construction		Very good
Ease of servicing		Very good
OVERALL AMPLIFIER PERFORMANCE RATING		Excellent

TABLE 3
RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: Yamaha

Model: CR-420

OVERALL PRODUCT ANALYSIS

Retail price	\$280
Price category	Low
Price/performance ratio	Superb
Styling and appearance	Excellent
Sound quality	Very good
Mechanical performance	Very good

Comments: Yamaha is an audio component manufacturer that does not sacrifice control or quality when "stepping down" to its lowered power receiver designs. The tuner section (at least the FM) of the model CR-420 exhibited performance characteristics as good as those of higher-priced models, and, even though the unit is not equipped with selectable IF bandwidth, a high-enough alternate channel selectivity was balanced with an adequate bandwidth, so that the distortion levels observed during our tests (at full 100% modulation levels) were incredibly low—often limited by the capabilities of our test equipment. Stereo separation in FM was very high.

Perhaps more important than the measured test results was the intelligent control layout. The separate record-out switch and program source switch are a welcome innovation in a receiver at this low price and permit you to record one program source while listening to another. Yamaha retained the center-of-channel tuning mode for the single meter when it is used for FM tuning. We wish that the MUTE switch had been made independent of the stereo/mono FM mode, since the present arrangement prevented us from checking out some weak-signal stations in the stereo mode.

At (or even slightly above) its rated power-output level, the model CR-420 delivers good tight sound that is well balanced and uncolored. With so many new speaker systems requiring no more power than the receiver can supply, it's nice not to have to opt for a super-powered unit just to obtain other high-quality features.

20-kHz bandwidth. The need for a second oscillator and mixer is eliminated.

This changes very little the way you approach overall troubleshooting. As you will see later, dual-conversion receivers require a generator that reaches accurately down into the submegahertz frequencies.

First things first

An excellent place to begin troubleshooting is around the discriminator. You need an accurate 10.7-MHz signal source, unmodulated. Of course, if the discriminator comes after a series of low-IF amplifiers, let's say, the 455-kHz variety—that's the signal source to use.

The important thing to remember is accuracy. Today's more expensive signal generators have plenty of accuracy. However, you should not attempt a discriminator adjustment with just any old signal generator. One of exceptional accuracy and tight stability is a must. Lacking an expensive generator, you may have to make do with one that has less stability; if so, *always* monitor its output with a frequency counter.

Once the discriminator is calibrated, turn your attention to the IF stages immediately preceding it. In the Fig. 1 example, this means you test the IF amplifier and limiter stages at a frequency of 10.7 MHz. In a dual-conversion receiver, this step deals with 455-kHz stages.

Go to the limiter first. You'll discover that a quick meter check of the action in this stage indicates some things about the operation back towards the front end of the receiver, without even injecting a signal. Monitoring the effects, at the limiter, of an input signal tells you even more.

After checking the limiter, assess the operation of the IF amplifiers and the associated selectivity filters. Again, certain tests reveal whether or not these stages and components perform the way they are intended to. If they don't, correct the trouble before you proceed. Some later tests will depend on the proper operation of these IF stages.

Alignment tells a story

Knowing that transmitter troubleshooting responds well to an alignment procedure in diagnosis, smart technicians apply similar techniques for the IF and RF sections of communications receivers.

Therefore, if the receiver is a dual-conversion set, you next switch your signal generator to the high intermediate frequency and test those stages. As you will discover, you can verify the accuracy of your signal generator by two measurements—one using your frequency counter, and another made at the discriminator of the receiver. (Details will follow later in this article.)

The same procedure works when you

TABLE 1—FM SIGNAL GENERATORS¹

Brand	Model	Frequencies	Accuracy (ppm) ²	Output (mV)	Tone-Squelch Frequencies (Hz)
Cushman	CE-4B	0.01-999.9999	3	100	10.0-9999.0
	CE-5	0.05-519.999	9	100	
ifr	FM/AM 1000A	0.03-1000.0	5	5	5.0-9999.9
Lampkin	107C	0.001-1000.0	5	100	10.0-9999.0
	109	2.0-512.0	10	50	
	303				
Singer/Ailtech	FM-10CS	0.05-1300.0	10	1	
Wavetec	3001	1.0-520.0	100	1000	
	3002	0.001-520.0	100	1000	

NOTES:

1—All but Wavetec are part of FM communications service monitors.

2—ppm = parts per million, each part equivalent to 0.00001% of dial frequency.

3—Dual-tone generator, with variable delays and durations.

check the receiver's RF sections. If the previous tests have been performed correctly, you can quickly zero-beat the receiver to a base transmitter or to a tightly controlled signal generator. (Today's generators (see Table 1) with digital settings have an accuracy that exceeds the FCC requirement for transmitters.)

Next on the agenda

It may come as a surprise that audio-and-squelch diagnosis follows the IF and RF troubleshooting procedure. Yet, using a meter to check most two-way radios makes it easy to check out most of these sections—up to and including the FM detector—without having to listen to the receiver.

Furthermore, only if all these tests come out as they should are squelch-system tests meaningful. This is because FM two-way radios depend on noise-operated squelch. Squelch problems in these sets often arise from defects in the RF or IF sections. Anything that reduces the amount of front-end circuit noise at the discriminator can cause "soft or erratic squelch." You could drive yourself crazy trying to track it down in the squelch section.

For this and other reasons, therefore, we suggest getting the discriminator, the low and high IF sections, and the RF and oscillator/mixer stages all in tip-top shape before you worry about squelch or audio.

Also, you can then check out the squelch and audio without having to use an audio generator. Simply feed a frequency-modulated signal (again, most modern generators can be frequency-modulated as well as amplitude-modulated) through the front end of the set (which you have proved OK) and proceed with testing.

This possibility becomes even more important when tone-coded squelch is involved. In these systems, receiver squelch opens up and "hears" only mes-

sages with an accompanying subaudio tone from the transmitter.

First, of course, you must understand how these squelch systems work. Second, you must be able to check the way squelch turns the audio on and off. Finally, you test how the squelch is opened up by the subaudio tone. This last requirement involves using a rather special audio generator, which is beyond the scope of this Special Section.

Final checks

One other important circuit within a receiver is the power supply. Certain DC voltages are regulated.

Before you undertake any other procedures, measure and verify that these regulated DC voltages are where they are supposed to be.

Not many mobile sets use electro-mechanical relays nowadays. Yet you may come across older gear that does use such relays.

Ordinarily, there are only two answers to relay problems: Either burnish the contacts or replace the relay. Only the most experienced relay expert is truly successful in trying to "bend the contacts" so they make and break in proper sequence. Considering the time you might spend on this procedure, and the likelihood of an early failure, your money is better spent on a new part.

Finally, do the customary final touch-ups. If a pilot light looks a little dark, it should be replaced because it will probably burn out soon. Dust out the chassis and clean up the front panel. Use a little alcohol on a Q-Tip to clean almost any corner. Remove knobs so you can clean behind them rather than leave a "ring around the collar."

Most important of all, service the set thoroughly. Whether you use the procedures described in this Section or ones of your own, check the set thoroughly. That's the only way to do the job conscientiously.

FM Detector And Filter Tests

Proper operation of FM detectors is vital to reliable operation of 2-way radio communication. Here's how they work and how to fix 'em.

BEFORE EMBARKING ON TESTS, YOU should understand how an FM demodulator works. Three basic types are used—discriminator, ratio detector and quadrature detector. Each is different, yet the principle of operation is roughly the same.

A frequency-modulated IF signal goes to the primary of a demodulator transformer. The signal is coupled inductively to the secondary. However, capacitance coupling also feeds the signal into the same circuits that are driven by the transformer secondary. This mixes inductively coupled and capacitively coupled signals, 90 degrees out-of-phase with each other.

A pair of diodes, connected in series-opposing at each end of the transformer secondary, act as detectors. However, the 90-degree phase difference causes them to conduct equally under one condition only—when the signal entering the transformer primary is precisely at the resonant frequency of the transformer primary and secondary circuits.

However, during frequency modulation, the signal deviates above and below the center frequency at an audio rate. Imbalance caused by the quadrature signals is proportional to the amount of frequency deviation.

Demodulators in double-conversion receivers center on a 455-kHz frequency. In others, the demodulator centers at whatever IF has been chosen; 10.7 MHz is usual.

Figure 1 shows an example of a basic FM discriminator that is used in many G-E two-way receivers. When the frequency swings above resonance, diode D1 conducts the most current. The voltage across the 220-pF capacitor becomes positive at the junction of D1. The farther the frequency deviates from center, the greater the positive voltage. When the frequency swings below resonance, diode D2 conducts the most current, and diode D1 conducts less. Voltage becomes posi-



LAMPKIN LABORATORIES MODEL 107C

tive at the junction of the capacitor and diode D2. Polarity across the capacitor thus alternates back and forth in step with the frequency deviation.

If you remember your frequency-modulation theory, you know that deviations occur at an audio or voice-frequency rate. The resulting alternating voltage across the 220-pF capacitor corresponds exactly with those voice frequencies. The RF is eliminated by the 220-pF capacitor. The demodulator thus recovers audio or voice modulation from the IF signals.

The discriminator shown in Fig. 2 differs only in how the quadrature or phase-shifted signal is fed to the secondary circuits. A "phantom center tap" is set up by a capacitive divider across the secondary.

The overall effect is identical. A signal precisely at resonance (of the transformer) results in the two diodes conducting equally and developing an equalized potential (0 volt) across the load capacitor. You can measure this zero voltage through a metering circuit—in Fig. 2, the 15K resistor and 0.01- μ F decoupling capacitor.

Either of two things can move this DC "output" voltage away from zero. First, if the center frequency fed to the transformer is slightly off—that is, not exactly at 455 kHz—the resting meter voltage reads slightly positive (above frequency) or slightly negative (below frequency). Second, with an exact incoming frequency, any misalignment of the transformer resonance, particularly secondary misadjustment, drastically alters the meter reading. In other words, the discriminator meter reads zero only when the incoming frequency is exactly 455 kHz, and when both transformer coils are adjusted to resonate precisely at 455 kHz.

From this, you can determine how to "calibrate" a discriminator; i.e., set it accurately at zero. Feed an accurate 455-kHz signal into the transformer from the limiter stages, and adjust the transformer coils for a zero reading at the discriminator metering point.

Just one precaution: The accuracy of this 455-kHz test signal is crucial. Use a crystal-controlled source, or a highly accurate synthesized generator, or keep a frequency counter on the generator you use. This is the only way you can truly calibrate the discriminator.

Figure 3 shows another type of demodulator. Note how the quadrature signal passes between two capacitive dividers, one across the primary and another across the special three-winding secondary of the discriminator transformer. This particular discriminator is used in Motorola two-way radios. Sometimes it is called a *phase discriminator*; some technicians call it a *capacitance discriminator*. The bottom part (inset) of Fig. 3 restructures the usual diagram to help you understand the operation of the demodulator a little better.

Diode D2 grounds the bottom end of the transformer secondary on the half-cycles in which the top end of the winding is negative (and the bottom end is positive). During that half-cycle, R1 is the load. Diode D1 couples the other end of the secondary to R2 on the other half-cycles. At resonance, D1 and D2 conduct almost identically. The DC voltages they develop show up across capacitor C4. Since these voltages are equal, they cancel each other. Therefore, the voltage at the metering point is exactly 0 (to ground).

Let the frequency being fed to the transformer deviate even slightly from

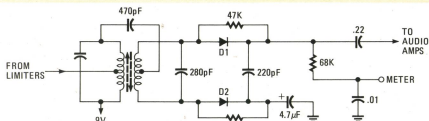


FIG. 1—BASIC FM DISCRIMINATOR is based on old Foster-Seeley design. The capacitor shifts phase by 90 degrees.

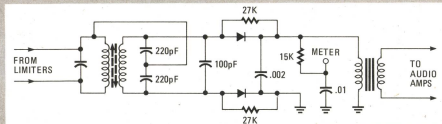


FIG. 2—DIFFERENCE IN SHIFTING PHASE does not alter the operation of this FM detector.

the transformer's resonant frequency and one diode conducts slightly more than the other. The voltage developed across C4 becomes something other than zero. If the frequency goes up, D1 conducts the most and the voltage at the metering point swings positive. Below resonant or center frequency, D2 conducts more and the voltage at the meter point is negative.

Hence, as frequency modulation deviates the signal up and down from the center frequency, the voltage across C4 follows the deviations closely and frequency demodulation occurs.

One thing you will discover when you examine the functional block diagram of almost any two-way radio is that a stage or two of *limiting* precedes the FM discriminator. *Limiters* are saturated stages that level out any amplitude variations that exist in a signal. It is important, for the recovered voice signals to be clear, that a discriminator type of demodulator be fed a pure FM signal. Many factors between the transmitter modulator and the receiver demodulator can vary the signal level, in effect adding some amplitude modulation. Most discriminators are sensitive to amplitude modulation, so limiters are necessary.

Once a limiter is saturated, it develops a base current that is somewhat proportional to the signal fed into the stage. Consequently, connecting a meter across a base resistor will indicate whether the limiter works or not. Virtually all commercial FM two-way radios contain at least one metering point for evaluating the limiter, which is why it's handy as an alignment indicator.

Broadcast FM receivers and some older communications receivers contain a variant called a *ratio detector*. The most notable circuit variation is that the diodes are connected as series-aiding rather than as series-opposing. Capacitors still produce a quadrature phase shift and the same results are obtained as with a discriminator; that is, frequency deviations cause a change in voltage across an output or a load capacitor and voice signals are recovered from a frequency-modulated IF signal.

A ratio detector effectively cancels the amplitude modulations that accompany the IF signal to the detector. Therefore, less limiting is needed. Nevertheless, you almost never find a communications receiver without limiters between the low-IF amplifier and the FM demodulator.

Modern systems

Figure 4 shows a modern-day FM demodulator. Instead of a discriminator transformer, a fixed-frequency ceramic filter couples the IF signal from the limiters to the diodes. Designed especially for this purpose, this unique filter offers an extra advantage: high selectivity. Aging seldom changes the filter's resonant frequency more than a few Hertz, so you never have to adjust it; it either works or it doesn't.

The 90-degree phase difference occurs in the discriminator filter itself. Two output voltages develop across R1 and R2, and are fed to diodes D1 and D2. Because they are connected in series-aiding, diodes D1 and D2 deliver a combined DC output voltage that is precisely zero when the frequency that is fed to the filter exactly matches its center resonance. Deviations up or down from the center frequency produce a net positive or negative voltage across R3. Capacitor C3

provides a time constant with this load fast enough to respond properly to voice frequencies, and yet slow enough to eliminate most of the IF component. Network L1 and C5, together with bypass capacitor C4, filter out any remaining 455-kHz signal. As a result, capacitor C6 couples voice signals onto the audio-amplifier stages.

As always in communications discriminators, there is a test point across the DC output. In this design, since you cannot adjust the quadrature circuit, this test point serves mainly to help you judge whether the filter discriminator is good or bad, or adjust the conversion oscillators.

State-of-the-art two-way radios use an IC for the limiter/discriminator sections. Even with these circuits, a 90-degree phase shift is necessary. So, you will find an adjustable quadrature transformer connected to two pins of the IC. This tunable coil serves the same purpose (insofar as adjustment is concerned) as the secondary of a discriminator transformer.

Figure 5 shows a simplified representation of an integrated-circuit FM demodulator system, with limiters and a quadrature detector contained in one IC.

The quadrature coil is located externally. Tuning it is similar to tuning the secondary of a discriminator or ratio detector, but with one significant difference. You do not align for a zero-centered

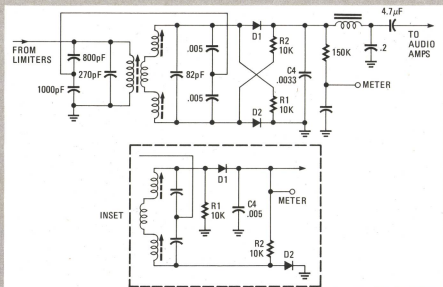


FIG. 3—CAPACITIVE DISCRIMINATOR incorporated in many Motorola two-way receivers; inset shows restructured circuits so you can understand how demodulators work.

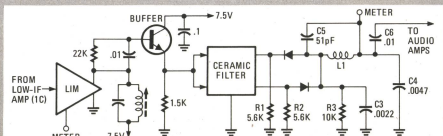


FIG. 4—FM DETECTOR (from marine VHF set) is driven by ceramic filter; it features high selectivity and cannot be adjusted.

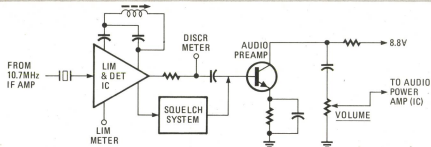


FIG. 5—IC'S IN MODERN DESIGN often combine a limiter and FM detector; the alignment coil is still external.

meter reading. Instead, with a very precise IF signal fed in from the IF amplifiers, you align for an exact 24- μ A meter reading. This happens to be "zero-center" on this quadrature-detector S-curve. Naturally, the circuit includes a detector metering point.

Limiter stages are part of the same IC. As is common practice, there is a metering point for measuring the limiter current. You can use limiter metering to adjust for RF and IF alignment.

The Fig. 5 set has an IF of 10.7 MHz. To calibrate the discriminator, use only a signal source that is synthesized with a digital readout, or is tightly crystal-controlled.

Testing FM detectors

The first test for a discriminator is whether or not it will zero-center properly. This is called "calibrating" the discriminator. (Earlier we stressed the necessity for signal-source accuracy.)

Another important point: **DO NOT** try calibrating the discriminator from the front end or, in double-conversion sets, with a high-IF signal. Why? If either oscillator happens to be off-frequency, you would zero-center the discriminator incorrectly, or you would unknowingly use an incorrect signal. Perform this part of troubleshooting using only an unmodulated IF signal.

Feed a precisely accurate 455-kHz low-IF signal into the base of the second receiver mixer. If the receiver is single-conversion, use whatever frequency the IF and discriminator take, but feed in the signal at the mixer base. The mixer stage thus isolates any capacitive effect the generator cable has on tuning of subsequent stages.

The signal should be very strong for this test and adjustment procedure. Set the generator-output level high—for at least 500 mV of IF signal.

Connect your DC meter at the discriminator test point. If the meter reads either side of zero, adjust the discriminator coil (the secondary—usually the bottom slug) to center the discriminator as closely to zero as possible. Make sure again that the test signal is precisely at the right IF; otherwise, any later adjustments will be incorrect. Also remember that, in some sets, zero center is at some specified meter reading.

If you can't zero the discriminator, this means trouble, and diodes are the most frequent offenders. Diodes should be fairly well matched; that is, forward resistance should be about the same in both. There should be almost *no* leakage. A faulty coil or capacitor can also prevent zeroing. Get this corrected before proceeding any further.

Next, test the discriminator for balance. This is where a decade-type generator frequency control comes in handy.

With the discriminator accurately zeroed, reset the generator frequency for 1 kHz *above* the center frequency. Note the new discriminator meter reading. Then, reset the generator frequency to 1 kHz *below* the center frequency. The meter reading should move in the opposite direction from zero and exactly the same amount. In other words, equal frequency swings above and below center frequency should result in equal but opposite voltage swings.

Diodes again are your prime suspect when a discriminator fails to show balance. Sometimes, however, a badly mistuned *primary* coil creates this effect, even when the secondary seems to zero normally. However, go easy; all primary tuning requires that you readjust the secondary for zero. Capacitor values that have shifted (as a result of age or heat) can also cause unbalance. In addition, check the decoupling for the primary winding and the discriminator secondary.

Poor discriminator balance can be caused by a faulty ceramic or crystal IF filter. Although this is not the usual symptom of a bad selectivity filter, don't overlook it. (In a moment we'll tell you how to test filters.)

Connect your DC meter at the metering point in the limiter stage nearest the discriminator. Adjust all low-IF transformer and limiter coils for a maximum reading at the limiter.



CUSHMAN MODEL CE-4B

For this check, don't feed in too much IF signal. Set the signal generator attenuator at zero and turn it up until you see the limiter reading rise slightly. If, when you align the IF and limiter coils, the reading goes higher, keep reducing the generator-output signal. If you oversaturate the limiters, these adjustments will be too broad and you won't obtain accurate alignment.

Broad adjustments in any case signify trouble. Look for a leaky transistor, a faulty transformer or an open decoupling capacitor. Eliminate the trouble before proceeding to any other part of the receiver.

Finding filter defects

Check out low-IF filters when you have your instruments connected for IF alignment. Keep the generator set exactly at the discriminator's center frequency. Feed in just enough signal to quiet some of the circuit noise heard in the speaker. Meter the limiter at the same time. You will note that slight quieting occurs after the limiter reading starts rising.

Now, set the generator-output high so the receiver is almost but not completely quieted. This signal level brings the limiter reading up to about halfway between threshold limiting and "flattening out" or oversaturation. It is important to hear a tiny bit of circuit noise, and note the limiter meter reading.

Now, raise the generator frequency exactly 1 kHz *above* the center frequency. Pay close attention to the increased noise level of the receiver and the exact degree of reduction in limiter reading.

Next, shift the generator frequency to 1 kHz *below* center. The meter reading should fall off almost exactly the same amount as for 1 kHz above the center frequency. Speaker noise increases.

You can make and interpret this test in a matter of seconds. If you have any doubts, swing the generator frequency 2 kHz above and below center. Again, the noise levels on either side of center should be the same, with matching reductions in the limiter reading.

If there had been any earlier unbalance in the discriminator or quadrature detector, this test indicates whether you can blame it on defective filters.

Sometimes, when a discriminator zeroes OK but cannot be balanced exactly, some careless folks settle for a compromise balance, with the discriminator resting a little off-center. This results in audio distortion, especially during full signal modulation from another station or transmitter. Always test both the discriminator and filter balance to be sure.

Where filters are ganged, you may wonder which one is bad. Try injecting the test signal between the two filters. Isolate the signal generator with a 50-pF capacitor in series with the cable. Injection tracing lets you isolate which filter has changed characteristic.



You Can

*An installment of a continuing series
readiness to qualify as a*

TRY YOUR HAND AT THESE SAMPLE TEST questions on electronic components and circuits. The answers to this month's and a new set of questions will appear in a future issue of **Radio-Electronics**. When you feel ready to take the CET Exam write to ISCET; 310½ Main St., Ames, IA 50010. Ask for the name and number of the nearest Certification Administrator, and take the CET exam.

Chapter 5 questions, electronic components & circuits

1. Which of the following statements regarding the circuit shown in Fig. 1 is true:

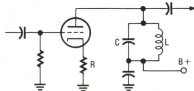


FIG. 1

- a. will pass all frequencies except one band near the resonant frequency of the L—C circuit.
- b. will reject all frequencies except one band near the resonant frequency of the L—C circuit.
- c. the value of R will determine the resonant frequency of the L—C tank circuit.
- d. resistor R provides regeneration for the circuit.

2. In the circuit shown in Fig. 2:

- a. R and C act as a tone control.
- b. R varies the frequency of oscillation.

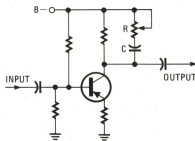


FIG. 2

- c. R varies the collector voltage.
 - d. R varies the DC voltage on C.
3. In the Fig. 3 circuit:
 - a. D will conduct when the voltage at E1 is lower than its breakdown potential.
 - b. D is a protective device which will cause R to open if E2 voltage rises above D breakdown voltage.
 - c. D will conduct when E1 voltage is

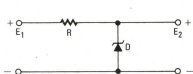


FIG. 3

- higher than its breakdown potential.
- d. the circuit is that of a simple half-wave power supply.

4. Regarding the circuit shown in Fig. 4:

- a. the circuit cannot work as D1 and D2 cancel any signal at E.
- b. the circuit could work as a regulated power supply.

- c. the position of the pointer at R

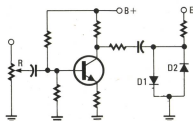


FIG. 4

would determine the DC voltage at E.

- d. D1 and D2 are noise limiters.

5. Regarding the circuit shown in Fig. 5:

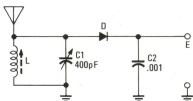


FIG. 5

- a. it will work best if a high impedance headset is connected at E.
- b. it cannot work without a power supply connected at E.
- c. it cannot operate over the entire AM broadcast band unless both the L and C1 are variable.
- d. the value of C2 will determine the station to be received.

6. The circuit shown in Fig. 6:

- a. could be used to turn on an alarm.
- b. is a sound-operated relay circuit.

Be A CET

of questions aimed at checking your
Certified Electronic Technician



DICK GLASS

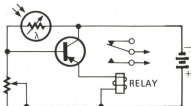


FIG. 6

- () c. can be used to measure fluid flow.
- () d. is an overload protector.

7. What type of circuit is shown in Fig. 7?

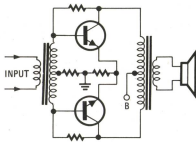


FIG. 7

- () a. a complementary symmetry amplifier circuit.
- () b. a push-push amplifier.
- () c. a push-pull amplifier.
- () d. an emitter-follower amplifier circuit.

8. The circuit in Fig. 8 is a:

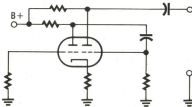


FIG. 8

- () a. multivibrator.
- () b. blocking oscillator.
- () c. Armstrong oscillator.
- () d. Hartley oscillator.

9. Figure 9 is a:

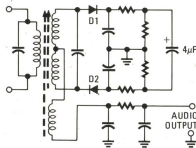


FIG. 9

- () a. ratio detector.
- () b. quadrature detector.
- () c. discriminator.
- () d. full-wave bridge.

10. In Fig. 10, pins 3, 4, 5, 7, 10, 11, & 12 of the IC might be used for:

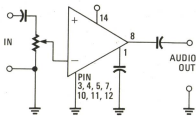


FIG. 10

- () a. heat sinks.
- () b. optional input level connections.
- () c. optional output level connections.

- () d. they have no purpose.

Be sure to keep this month's issue of **Radio-Electronics** so you can check your answers in the next CET test. **R-E**

Answers To Prior Quiz

Correct answers to Chapter 4 questions on transistors and semiconductors

Here are the answers to the questions on transistors and semiconductors that appeared in the November 1978 issue.

1. Correct answer is "b." Collector and emitter DC voltages on transistors vary widely. Determining that either of these elements has a DC voltage is useful in troubleshooting but the most useful check is to see if the bias voltage (emitter-to-base) is in the range that will permit the semiconductor to operate.
2. Correct answer is "d." The collector of an NPN transistor is positive in relation to the base and emitter. The emitter would be approximately 0.6 volt more negative than the base.
3. Correct answer is "a."
4. Correct answer is "a."
5. Correct answer is "d."
6. Correct answer is "c": A tunnel diode is unique in that it will oscillate at UHF frequencies.
7. Correct answer is "c."
8. Correct answer is "a."
9. Correct answer is "b" (an N-channel JFET).
10. Correct answer is "c."

Advanced Electronic Career

ANNOUNCING ... A New CREI Program: Minicomputer & Microprocessor Technology Including A Microprocessor Laboratory

Now you can learn at home
the new technology that is
revolutionizing electronics

The microprocessor has ushered in the age of microtechnology and electronics will never again be the same. The microprocessor has made possible the placing of an entire computer on a silicon chip one quarter inch square. The microprocessor "miracle chip" is in the process of changing the world. Soon all technical personnel in electronics will have to understand and work with the microprocessor. It is invading virtually every area of electronics. And it is profoundly affecting your electronics career.

Brand New Program

CREI has a brand new program to help you learn how to work effectively with this revolutionary electronics development. CREI's new program in Minicomputer and Microprocessor Technology is designed to prepare you for this field by giving you the education and practical experience you need.

The program provides solid preparation in electronics engineering technology with a specialization in minicomputers and microprocessors. In addition, it includes a microprocessor laboratory which features a fully programmable microcomputer which utilizes the Motorola 6802 microprocessor chip. This is an extremely important element of your program.

Programming Essential

As you may well know, you must learn how to *program* the microprocessor in order to design, service or troubleshoot microprocessor electronic systems. There is only one effective way to learn this all-important skill of programming, and that is by actually *doing it*. CREI's new program gives you this opportunity as you work with the exciting microprocessor laboratory.

Programming Is Easy

With CREI's new program, learning the skill of programming is simple. Within a few hours you'll be programming the microprocessor and in a short time you'll learn how to program it in three languages: BASIC, assembly and machine languages. In addition, you will learn how to interface the microprocessor with other systems and to test and debug specialized programs.

Preparation at Home

Wide Choice of Programs

Please note, however, that CREI's new program is only one of 16 state-of-the-art programs in advanced electronic technology offered by CREI. So even if you choose not to specialize in microprocessor technology, CREI has an advanced electronics program to meet your needs.

With CREI, you may choose from any of the following areas of specialization in advanced electronics:

- Microprocessor Technology
- Computer Engineering
- Communications Engineering
- Digital Communications
- Electronic Systems
- Automatic Controls
- Industrial Electronics
- Television Engineering
- Microwave Engineering
- Cable Television
- Radar and Sonar
- Nuclear Instrumentation
- Satellite Communications
- Aeronautical and Navigational
- Solid State Theory
- Nuclear Engineering

Unique Lab Program

An exclusive option available with CREI programs in electronic engineering technology is CREI's unique Electronic Design Laboratory program. It gives you actual experience in designing practical electronic circuits. It also helps you to understand the theories of advanced electronics and gives you extensive experience in such areas as tests and measurements, breadboarding, prototype construction, circuit operation and behavior, characteristics of electronics components and how to apply integrated circuits. Only CREI offers this unique Lab Program.

Practical Engineering

CREI programs give you a practical engineering knowledge of electronics. That is, each part of your training is planned for your "use on the job." By using your training, you reinforce the learning process. And by demonstrating your increased knowledge to your employer, you may qualify for faster career advancement.

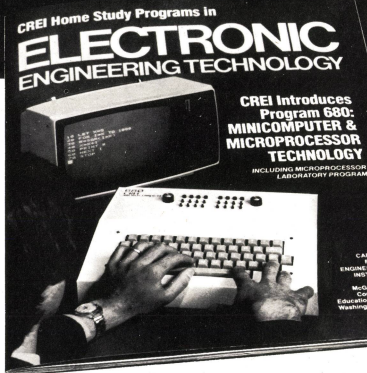
Free Book

There isn't room here to give you all of the facts about career opportunities in advanced electronics and how CREI prepares you for them. So we invite you to send for our free catalog. This fully illustrated, 56 page book describes in detail the programs, equipment and services of CREI.

Qualifications

You may be eligible to take a CREI college-level program in electronics if you are a high school graduate (or the true equivalent) and have previous training or experience in electronics. Program arrangements are available depending upon whether you have extensive or minimum experience in electronics.

Send for this FREE Book describing your opportunities and CREI college-level programs in electronics



Mail card or write describing qualifications to

CREI **CAPITOL
RADIO
ENGINEERING
INSTITUTE**

McGraw-Hill Continuing Education Center
3939 Wisconsin Avenue Northwest
Washington, D.C. 20016

Accredited Member National Home Study Council

GI Bill

CREI programs are approved for training of veterans and servicemen under the G.I. Bill.



HOBBY CORNER

Learn solid-state circuitry as you complete your monophonic music maker.

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

DID YOU GET YOUR MULTIPLE-TONE GENERATOR and note selector assembled and operating (see "Hobby Corner," *Radio-Electronics*, January 1979)? This month it's time to add an automatic controller system. We'll build a push-one-button-to-play circuit and then add triggers.

The push-to-play circuit calls for a pulse generator and a counter. Figure 1 shows a basic 555 astable multivibrator used as a variable-rate pulser. The rate and, therefore, the length of each note in the tune is determined by R1, R2 and C1. You can increase or decrease any of those components to change the available range of lengths.

Pressing switch S1 removes pin 4 from ground; this enables the 555 pulser that puts out (pin 3) a string of pulses for as

The 7404 inverter between pin 4 of the 555 and pin 2 of the 7493 does two jobs. It returns the counter to zero when the 555 is disabled, thus insuring (1) that the tune starts at the beginning regardless of where it stopped, and (2) that zero output pin 1 (74154) is activated. Since no tone was connected to the pin 1 output, the device is silent when S1 is not pressed.

You can use switch S1 to turn on a doorbell, as an alarm clock output or any other device of your choice. As long as the switch is activated, the tune plays. The circuit now plays as much of your tune as there is time for. That's OK, but it seems unfinished!

So let's add another 555 to make the circuit play the tune in whole multiples only—no more part tunes. The 555

Why not use a 556 dual timer in place of the two 555's? Sure, you can do that, but right now we're going to talk about adding even more controller timers.

Control timers

Suppose, for example, that you would like to use your tune player in place of a doorbell, and you have two doors. If you use two switches on one controller timer, it won't be possible to know whether your visitor is at the back or the front of the house. To solve this problem, set up another controller 555, as shown in Fig. 2. Adjust the timing so that one controller plays one-half the tune and the other controller plays the whole tune, or the whole tune once and twice. If your home has three doors, just use three controllers.

When you use more than one 555 controller, you cannot simply tie all the outputs together. The most direct method is to use one or more OR gates (see Fig. 3). If one or more inputs goes high, then the output also goes high and activates the pulser.

There is one more potential problem: Perhaps a heavy-handed visitor or some other occurrence triggers and re-triggers a controller when you don't want it to repeat. For example, suppose you want the alarm clock to repeat until you turn it off but you don't want to activate the on-

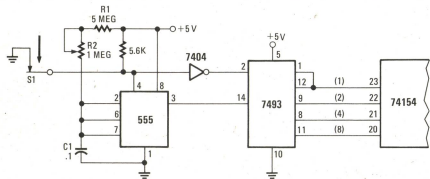


FIG. 1—PUSH-TO-PLAY circuit.

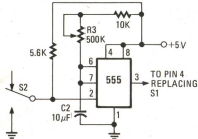


FIG. 2—MONOSTABLE controller circuit.

long as the switch is open. The 7493 binary counter counts the pulses and encodes them to binary 0-15 for the 74154 note selector. This arrangement, of course, replaces the four manual switches that were added temporarily to the 74154 input, as described last month.

monostable shown in Fig. 2 will do just that.

Remove the pin 4 line from the pulser and connect it to the controller output, pin 3. Now just a quick tap on S2 starts the tune, and it plays until the controller times out. Adjust R3 until the time-out occurs right at the end of the tune. (Depending upon how long each note sounds, you may have to change the value of R3 and/or C2 to get into the correct timing range.)

Now you have a doorbell, clock alarm or whatever other device you like that plays your tune through to the last note regardless of how long S2 is closed. Of course, it may play it five or 10 times if your visitor has a heavy finger, but this feature is good to have on a clock alarm if you are a heavy sleeper!

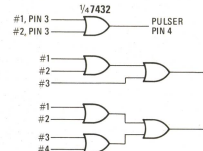


FIG. 3—CONTROLLER COUPLERS.

the-hour chime. The circuit shown in Fig. 4 causes the controller to trigger once and only once for each closing of switch S3 no matter how long it is closed.

The single trigger circuit is a little tricky. In fact, you can provide different effects by changing the values of R4 and C4 and even by taking out the diode across the capacitor. These possibilities are available: (1) a single trigger when S3

is closed and another when it is opened; (2) a single trigger on closing and another available as soon as the first time-out is completed; and (3) a single trigger on closing following by a "dead-time" of from several seconds to several minutes during which the switch will not re-trigger. The values given in Fig. 4 put my prototype in case (2) above, but much depends upon the quality of C4 and how much leakage it has.

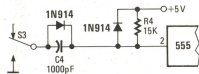
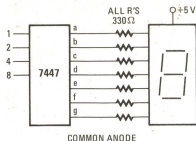
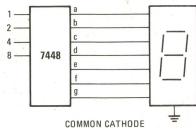


FIG. 4—SINGLE-TRIGGER (time-out) circuit.



COMMON ANODE



COMMON CATHODE

FIG. 5—TWO READOUTS AND DRIVERS.

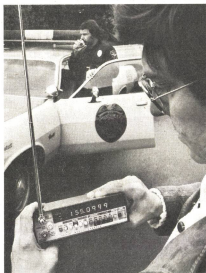
There are many variations that you can make in these circuits. Build a tune-maker to suit your needs and, then, package it accordingly. Here are just four more ideas:

1. Use gates to detect the 15, 30, 45 and 00 minutes on your digital clock and trigger tune-maker chimes.
2. Put in a second 74154 and 7493 to give you a 30-note capability.
3. Drive the 74154 with an 8573 or an 8574 (256 × 4 PROM) for 256 variations of your 16 notes.
4. Take a fistful of 1N914's and build a diode matrix to select any number of notes.

Let us know what you have done with the tune-maker, and we'll share as many ideas with other readers as possible. Have fun!

R-E

Why buy a multi-capability counter for frequency-only measurements?



The 1911A multicounter makes accurate field transmitter frequency checks easy with the optional battery-pack and whip antenna.

For accurate readings in the presence of noise. Our new 1911/12A multi-counters have both trigger-level and attenuator controls.

For high resolution measurement of low frequency control tones in the period or period-average mode.

For economy. They're priced about the same as many frequency-only models, with totalize, autozero, autoranging, manual and automatic range selection, and more. Standard.

- 1911A for 250 MHz applications: \$495.*
- 1912A for measurements to 520 MHz: \$620.*

Call (800)426-0361, toll free, or write: John Fluke Mfg. Co., P.O. Box 43210, Mountlake Terrace, WA 98043.

*(U.S. price)



1912A 520 MHz model

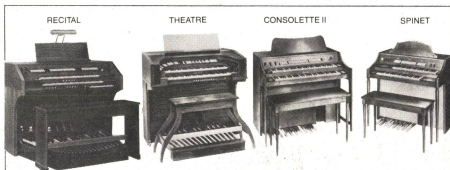
Fluke Multicounters for Communications Service



2110-8001

CIRCLE 46 ON FREE INFORMATION CARD

CIRCLE 72 FOR DEMONSTRATION



You can assemble any of these Schober Organs

—and save 50% off store prices.

This coupon will bring you the fascinating Schober color catalog which describes the organs and shows you how easy it is to assemble them from Schober's complete kits. Include \$1 if you want a 12-inch demo record.

The Schober Organ Corp., Dept. 183
43 West 61st Street, New York, N.Y. 10023

- ☐ Please send me the Schober Organ Catalog.
☐ Enclosed is my \$1 for the 12-inch demo record.

Name

Address

City State Zip

H
HIGH BLOOD PRESSURE.
Treat it...and live.

The National High Blood Pressure Education Program,
U.S. Department of Health, Education, and Welfare.

CIRCLE 31 ON FREE INFORMATION CARD

computer corner

8085 *A look at one memory IC that is among the 8085 family of devices.*

J. TITUS, C. TITUS, D. LARSEN AND P. RONY

IN A PREVIOUS COLUMN (JANUARY 1979), we described the new Intel 8085 microprocessor IC. This is an upgraded type of 8080 microprocessor, since it has features that are not found on the 8080 device. One of the advantages in using the 8085 is the availability of "family" devices that can be used with little or no additional external logic. This makes the 8085 and its family ideal for small controllers, instruments and games, where ex-

pansion and the ability to run large programs such as BASIC may not be required.

This month we will describe one of the 8085-family devices, the 8155 read/write memory.

8155 RAM

The 8155 read/write memory IC contains 256 bytes of memory, which is probably more than enough for a small system. In most cases, the read/write memory will be used for temporary storage of data or results, as well as register and address information. The 8155 is also bus-compatible with the 8085 system through the use of the bidirectional address-data bus and standard control sig-

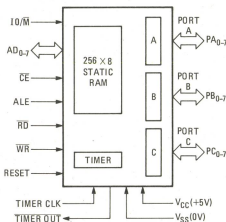
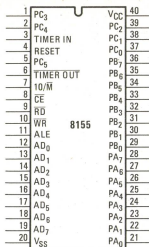
nals. In this case, only the $\overline{IO}/\overline{M}$, \overline{RD} and \overline{WR} signals are necessary for memory control. The \overline{ALE} , \overline{CLOCK} and \overline{RESET} signals from the 8085 are also provided for internal control of the IC.

The 8155 has some I/O lines—in fact, there are two 8-bit I/O ports and one 6-bit I/O port. The two 8-bit I/O ports can be operated in either the input or output mode; individual bits cannot be selected. These two ports are called ports A and B. The 6-bit I/O port (port C) can be operated in several ways, but these are beyond the scope of this article. Let us just say that these operations allow the I/O ports to perform in a manner similar to that provided by the mode 1 and mode 2 operation of the 8255 programmable peripheral interface.

The 8155 read/write memory also contains a 14-bit programmable counter, re-



costly call- backs..



Control Bits		Mode Of Operation
M2	M1	
0	0	Output a logic 0 during the second half of the count.
0	1	Output a squarewave, same as 00 above, but reload and restart the count at the end of each count sequence.
1	0	Output a single short pulse at the end of the count sequence.
1	1	Output a single pulse at the end of the count, but reload and restart the count at the end of each count sequence.

ferred to as a timer. The timer uses either the 8085's clock output or an externally applied clock signal. The timer's output is available as a pin on the 8155 IC, and it can be used several ways, depending on your requirements. It could be connected to the Serial Input Data (SID) pin 5 to be sensed by the RIM instruction, or connected to one of the 8085's interrupt pins (RST 7.5, for example) so that the end of the timer's period could be detected via an interrupt. The timer's output is fairly flexible, being programmed to operate in one of four ways:

Control bits M2 and M1 are the most significant ones in the 16-bit value programmed into the counter. Since the counter is only 14-bits-long, the control bits are not included in the count itself, but are used by the control logic to determine the counter-output state when the count has been finally decremented to zero. Whenever a new 14-bit count value is reprogrammed into the counter, these two control bits must also be included in the new 16-bit word.

The 8155 read/write memory also has an internal counter register that is loaded with an 8-bit byte that is used to determine operation of the I/O ports and the 14-bit counter.

R-E

make more money with RCA SKs...

... and your customers will really appreciate your reliable service.

You eliminate costly call backs because: with RCA SKs you know you're using the best. RCA guarantees it. We'll replace any defective SK within one year of purchase by the dealer. We can afford to make this offer because our malfunction rate is one of the lowest in the industry — less than one percent.

With RCA SKs you know your customer is getting the right semiconductor. Our SK line includes over 900 replacement transistors, rectifiers, thyristors, integrated circuits and high voltage triplers that meet or exceed the OEM standards for the 150,000 domestic or foreign semiconductors our SKs can replace.

You save time because you'll identify the exact SK you need quickly in RCA's easy-to-use Replacement Guide with complete installation data. And on every SK package you'll find all the necessary technical specifications and terminal diagrams.

All hardware, when needed, is also included right in the SK package which saves you extra trips back to the truck or back to the shop.

You make more money because: you can work faster, more efficiently with RCA SKs. And you virtually end costly call-backs which means a lot more satisfied customers as well.

For details on how to order, see your RCA SK Distributor. Or contact RCA Distributor and Special

Products Division, Deptford, N.J. 08096, Attention: Sales Promotion Services.

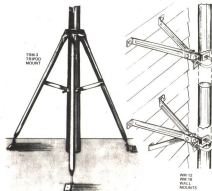


RCA
SK Solid State
Replacement

communications products

More information on new products is available from manufacturers of items identified by a Free Information number. Free Information Card is inside the back cover.

ANTENNA MOUNTS, model TRM-3, model WM-12, model WM-18. The heavy-duty model TRM-3 is a 3-foot-high tripod that accommodates TV, FM, CB and antenna masts to 1½ inches in diameter. It can be roof-mounted or used in the field without bolting the legs. Comes fully assembled, with cap screws and hex nuts for securing the mast.



CIRCLE 126 ON FREE INFORMATION CARD

The models WM-12 and WM-18 are 12-inch and 18-inch wall mounts, respectively; both include brackets, U-bolts and hardware for up to 1½-inch diameter masts. List prices: model TRM-3, \$16.80; model WM-12, \$9.50; and model WM-18, \$13.45.—RMS Electronics, Inc., 50 Antin Place, Bronx, NY 10462.

TWO-METER TRANSCEIVER KIT, model HW-2036A, has a 143.5-MHz—148.5-MHz operating range and features a phase-locked synthesizer/VCO loop and choice of simplex, or ± 600 -kHz split operation. Features tone encoding, built-in 5- and 11-VDC regulators, hash filter/regulator and gimbal mount. The model HW-2036A-1 (with

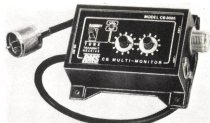


CIRCLE 127 ON FREE INFORMATION CARD

Micoder II mike/auto patch) costs \$289.95; the model HW-2036A-2 (with standard PPT mike) costs \$269.95.—Heath Co., Dept. 350-640, Benton Harbor, MI 49022.

CB MULTIMONITOR, model CB MM6, is designed for 23- or 40-channel mobile/base station equipment and offers six functions in a single unit: An antenna-matching network to adjust

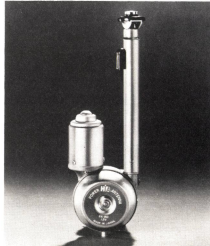
SWR; an SWR bridge and reflected power indicator; a built-in low-pass filter (to eliminate second and third harmonics); a complete antenna monitoring system with warning light; a built-in dummy load with modulation indicator; and a choice of



CIRCLE 128 ON FREE INFORMATION CARD

using a regular mobile CB antenna or AM/FM antenna for CB communications. The unit comes with two antenna inputs. Other specifications include a 26.5-MHz to 27.5-MHz frequency range, handles 5 watts of input power, 50-ohm input impedance, up to 4:1 VSWR mismatch correction, and spurious signal suppression of -25 dB. The model CB-MM6 measures 2½ W × 4 L × 1¼ inches H, and lists for \$49.95.—RMS Electronics, Inc., 50 Antin Place, Bronx, NY 10462.

AM/FM POWER ANTENNA, model FA-80, features a 10-pole motor and is fully shielded against noise transmission and reception. The antenna is completely automatic—it is activated and deactivated by the vehicle's ignition system; as an option it can be connected to car radio's on-off



CIRCLE 129 ON FREE INFORMATION CARD

switch. The flush-mounted head protects against theft.—Harada Industry of America, Dept. P, 145 E. Albertoni St., Carson, CA 90746. R-E

AUDIO TEST STATION

continued from page 48

Rotary switch S3 selects the integrating capacitor, and the charging current is determined by the networks connected to IC201 pins 4 through 7. Small-value capacitors charge faster than larger capacitors for the same charging current so a smaller capacitor selected by S3 will produce a higher frequency. Also for a given capacitor, increasing the charging current by varying R1 and R2 also increases the frequency.

The comparator or squarewave output from pin 13 is applied to Q201, an external buffer. The buffer is necessary because the internal squarewave buffer is an open collector, and the output impedance on the positive edge of the squarewave is equal to R201. Therefore, any significant change in the external load on pin 13 alters the amplitude of the positive edge of the squarewave.

The two resistor networks connected to pins 4 through 7 each control a separate current source for charging the integrating capacitor. These sources can be used singly or in pairs. When used in pairs, the currents of each are added. The voltages applied to IC201 pins 8 and 9 determine which of these current sources is active.

The outputs of both pins 13 and 14 are approximately symmetrical around 0. The output of Q201 ranges from approximately 0 to +V (+6 volts). With S4 in the SYMM position, IC201 pin 8 is at level 0 and pin 9 at +V. This enables both pins 6 and 7 and, therefore, the charging current from the integrating capacitor for both the positive and negative ramps is the total current drawn from pins 6 and 7. When the wiper of R1 is at ground, only a very small current is drawn from pin 7, and the charging rate, or frequency, is determined by R204. Resistor R204 therefore determines the low frequency point when R1, the front panel frequency-adjust slide pot is at the minimum setting. When the wiper of R1 is at -V (-6V), most of the charging current is provided by R205, since it is much smaller than R204. Resistor R205 then determines the high frequency limit when R1 is at the maximum setting. With these values for R204 and 205, the frequency range of R1 is 100:1. The reason that R204 and R205 are not also 100:1 is because even with R1 at ground, R205 contributes slightly to the charging current and therefore R204's contribution must be reduced to compensate. When R1 is at -V, the R204 contribution is negligible compared with that of R205.

When S4 is in the RAMP position and the output from IC201 pin 13 is high, pin 8 is also high. In this case, pins 4 and 5 are activated and they perform exactly as do pins 6 and 7. Remember that the squarewave output of pin 13 is at a constant voltage during rise of the ramp

voltage of pin 14. Therefore, during the positive-going ramp of pin 14, the current is controlled by pins 6 and 7. During the negative portion of the ramp, current is controlled by pins 4 and 5; or, as viewed from the front panel, R1 controls the time of the positive-going ramp and R2 controls the time of the negative-going ramp. If R1 and R2 are in extreme opposite positions, the result is positive and negative ramps with a 100:1 time ratio. With S4 in the ground (symmetrical) position, R1 controls the time of a symmetrical triangular waveform. The result of all this (looking at the front panel), is that R1 and R2 provide a 100:1 change of frequency, and each step of S3 provides a 100:1 change.

We know that the timebase section derives its name from the fact that its primary function is to sweep the audio generator and the time (actually the inverse of time—frequency) base of an X-Y display. To accomplish this, the timebase only has to provide a variable-symmetry triangle wave at low frequency. However, once the basic oscillator is established, it is relatively easy to let it provide other useful functions.

For instance, an effective way to check the proper action of a mixer is to apply two triangle waves, one, high-amplitude at a low frequency; the second, a lower amplitude at a higher frequency. If the mixer is functioning properly, each input retains its individual characteristics at the output, but one input will be riding on the other. The timebase section was designed to provide the three basic waveforms over at least the full spectrum of needed audio frequencies.

A piece of test equipment that many classify as "nice to have" but difficult to justify as a separate purchase is a pulse generator. Again, however, since there is already a basic oscillator in the timebase section, it is relatively simple to shape it into a pulse output. Therefore, the total frequency range of the timebase oscillator is made as wide as the capabilities of the basic oscillator can provide.

You then have a three-function generator with a useful frequency range of 0.002 Hz to 100 kHz and a pulse repetition rate of 0.002 Hz to about 800 kHz. The pulse-shaping section will be covered next month.

To provide the maximum possible versatility to the timebase oscillator, the range of integrating capacitors has been made as wide as practical. There is no DC bias across the integrating capacitor, and the manufacturer of IC201 has specified that the capacitors be nonpolar. This requirement is easily implemented for small-value capacitors; however, large-value nonpolar capacitors are rare and usually large sized.

The problem with using a polarized-type capacitor in a bipolar circuit is that the polarized capacitor tends to leak when you try to charge it in the reverse direc-

tion. If the leakage represents a significant portion of the charging current, the voltage rise across the capacitor (and hence across the output triangle wave) will be an exponential rather than a linear rise. This is because the leakage current increases with the charging voltage. If the leakage is significant, then at some voltage level, the leakage current and charging current will be equal, the voltage will cease to rise and oscillation will also cease. Additionally, some types of polarized capacitors can be damaged by reverse voltage.

Actually, this circuit works quite well with some aluminum electrolytic capacitors. With a supply voltage of ± 7 , the

charging voltage is only about ± 1.5 . Aluminum electrolytic capacitors can tolerate the 1.5-volt reverse voltage. However, low-leakage capacitors, and only those with the lowest voltage ratings, should be used in this circuit.

Note that the integrating capacitors are all evenly spaced one decade apart except for the largest and smallest capacitors. The 470- μ F value capacitor is simply the largest value that will consistently work in this circuit. Also note that the smallest capacitor (C203) must be reduced from its nominal value by an amount that is equal to the stray capacitance of the board and switch circuit.

continued on page 82

A 20MHz OSCILLOSCOPE UNDER \$500?



YES !!

LBO - 507 by

LEADER
Instruments Corp.

FEATURES:

- 20 MHz bandwidth
- Unique trigger circuit for maximum display stability
- 10 mV sensitivity
- Bright display
- TV trigger
- Built-in calibration signal
- Triggered and automatic sweep
- Built-in TV vertical and horizontal sync separation circuits
- Check most digital logic circuitry, including CMOS
- 18 sweep range selections
- Sweep to .1 μ SEC/cm

SPECIFICATIONS

VERTICAL AMPLIFIER	SENSITIVITY:	10mV/cm - 200V/cm (CALIBRATED IN 11 STEPS) 1.0k SEQUENCE UP TO 500V/cm WITH VARIANCE CONTROL
	BANDWIDTH:	7.5 MHz (100:1 SWEEP) 100k, 4 cm/sec (100:1 SWEEP) 100k, 4 cm/sec (100:1 SWEEP) 100k, 4 cm/sec
TIME BASE	SWEEP SPEED:	100:1 MICRO SECOND - 100:1 MINUTE, 10 STEP, 1.0k SEQUENCE UP TO 1000V/cm WITH VARIANCE CONTROL
	ACCURACY:	7.5% at 7.5 MHz MAX SPEED (100:1)
SYNCHRONIZATION	TRIGGER:	TRIGGERED & AUTOMATIC
	INTERNAL OR EXTERNAL - CH - SLOPE:	TRIGGERED (0.1 μ - 100k AT 100k) 0.01 μ - 100k AT 100k
HORIZONTAL AMPLIFIER	SENSITIVITY:	200V/cm (100:1) 100k AT 100k 0.01 μ - 100k AT 100k
	SWEEP:	0.1 μ - 100k AT 100k

NEWCOM SHOW SPECIAL !!

MIDWINTER SPECIAL

Save \$100 Regularly \$549.95
Now \$449.95 including probe
Shipping not included
Sale ends April 30, 1979



212-687-2224

THE TEST EQUIPMENT SPECIALISTS

TOLL FREE HOT LINE
800-223-0474

54 West 45 Street, New York, N.Y. 10036

ADVANCE ELECTRONICS

service clinic

Troubleshooting starter circuits in pulse-width modulated power supplies.

JACK DARR, SERVICE EDITOR

THE AUGUST 1978 SERVICE CLINIC, WE discussed pulse-width modulation (PWM) power supplies, and briefly mentioned the starter circuit. Now let's explain this circuit in more detail. This circuit is absolutely indispensable because it gives the horizontal oscillator circuit a swift kick to get it started. The PWM circuit *must* receive gate pulses from this circuit to operate. So, all PWM power supplies use some form of starter circuit. Keep in mind that all this activity takes place in a fraction of a second! When power is applied, the B+ voltage comes up very quickly in all solid-state circuits. Oscillator, driver and horizontal-output circuits start just as quickly.

So, all it takes is a short pulse of DC voltage, somewhere near the right value to get the oscillator going. Once the oscillator is running, the horizontal-output stage starts, as well as the PWM supply, and everything takes off. Some of these stages use quite complex circuits, but basically they're all similar. For example, the RCA CTC-85 color chassis circuitry looks complicated but isn't (see Fig. 1).

The B+ line (unregulated) is provided by a nonisolated bridge rectifier, from the AC line through L201—an AC line choke. At turn-on, a current pulse comes from the + terminal of the bridge and flows through the primary of start-up transformer T201. The current flows through this transformer because a large electrolytic 800- μ F capacitor, C304, is connected to it (C304 later becomes a filter capacitor).

When a capacitor of this size is discharged, it resembles a short circuit to a current source. Translation: the current flows into the capacitor until it is fully charged. While this is flowing, we get a pulse of current through the primary of T201. The transformer's secondary develops the two DC voltages needed—+22 and +27 VDC through the rectifier diodes and filter capacitors. These DC voltages now feed the horizontal oscillator, driver and buffer stages. When these stages start operating, they generate drive pulses to feed the horizontal-output stage and the PWM circuitry (this is on the regulator-control module). The PWM circuit feeds a regulated B+ voltage to

the horizontal-output stage.

Now that we've got our starting kick and things are going, we have to disable the starter circuit or it might interfere with the normal DC supplies, which are all developed by the flyback. The following method is used in all the starter circuits I've seen so far.

In Fig. 1, note D301 and D304, which are connected to the starting DC lines feeding the oscillator, driver, etc. During start-up, these two diodes are reverse-biased and do nothing. There is a +DC voltage on their cathodes but no voltage at all on the anodes. This is because the normal supply voltage is not working yet. (Remember this is taking place in a very short time!)

Shortly thereafter, the oscillator circuit and other stages are fed their normal supply voltages, so that they continue operating. Now, the starter circuit has no AC supply to keep it running. The start voltage drops. The starter diodes are now reverse-biased and cut off (there is a + voltage on the cathodes, and no voltage at all on the anodes). This isolates the starter transformer from the DC lines, which

stays inactive until the set is turned off again. This diode reaction is used for all the starter control circuits I've seen so far.

An interesting test, mentioned in the RCA *Technical Manual*, can be performed. If the starter circuit is not working, nothing happens. After checking the starter diodes, the filter capacitors, transformers, etc., for shorts and opens, you can start the horizontal oscillator by momentarily connecting a +22 VDC supply to the +27-volt input. All it takes is a very short current pulse somewhere near the normal voltage. (Although I haven't tried this, it looks as if you could do this with a bias box. The RCA manual suggests using a 22.5-volt battery, but these batteries are not very common.)

Check the starter circuit for a short DC pulse just as the set is turned on. It is best to use an analog meter because even a small kick of the needle is detectable. Set the meter to approximately the 15-volt scale so that the motion of the needle is easier to observe.

Most problems in these circuits can easily be located with the standard tests—checking diodes, filter capacitors, transformers, etc., for shorts or opens. In the RCA CTC-85 chassis, the entire B+ supply is isolated from the AC line by

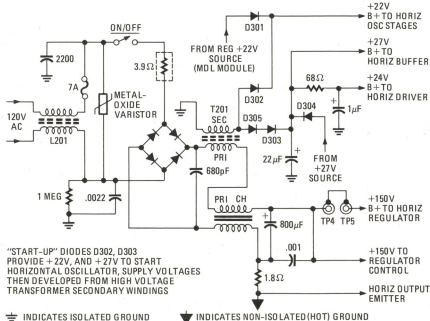


FIG. 1

the horizontal-output transformer; the unregulated B+ supply is not. This leads to the use of two "grounds," one isolated, the other "hot." However, this ground lead isn't really very hot, since it's only a very little way (one diode drop and a 1.8-ohm resistor) away from the isolated ground, or B- line. So little, in fact, that the hot ground can be used as the test equipment ground lead for voltage and waveform checks.

The starter circuit is not difficult to troubleshoot if you know what it does and how it does it. It's just that trying to explain the procedure isn't easy! The PWM won't work till the oscillator starts, the output stage won't work till the oscillator starts, but the output stage must be running to feed the oscillator! Something like the mythological worm with its tail in its mouth!

Thanks to RCA for the CTC-85 *Color Chassis Technical Manual*, which provided Fig. 1 and much data. **R-E**

service questions

HEATER STRING SHORT

There's a short in a Sears 19-inch color set that I can't find. The 5-amp fuse in the heater string blows quickly. The 40K06 tube was bad, as well as the 12BY7 tube. Any ideas?—M. R., E. Chicago, IN.

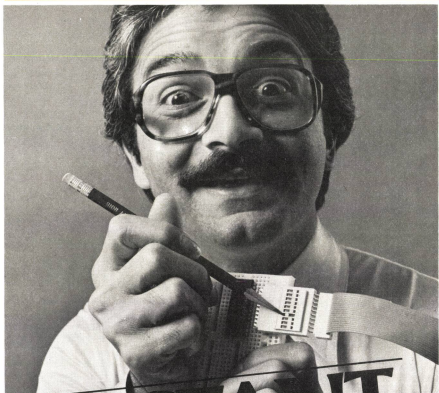
A common cause of this kind of trouble is a heater-to-cathode short in one of the tubes, perhaps one in the middle of the series circuit. (Note: The cathode of the tube must be directly grounded to cause this particular short.) When it happens, the heater circuit is grounded in the middle; this raises the heater voltage on all tubes between the short and the source, and it will usually blow some of the tubes.

(Feedback: "Bulls-eye! I found a 6GH8 tube with the heater-to-cathode short, and another 12BY7 tube was open.")

VERTICAL BLACK LINES

I've had problems in several TS-934 Quasar chassis with one or two small vertical dark lines at the left side of the screen. So far all I've done is try new damper and horizontal-output tubes until I find some that help. Do you have any data on this?—L. J., Eveleth, MN.

Quasar's booklet, *6 Years of Servicing*, says that this problem can be caused by damaged insulation on the red wire between pin 5 of the high-voltage transformer and pin 9 of the damper tube. The cure is to place heavy plastic sleeving over this lead to prevent leakage to the edge of the chassis. (This lead is on the socket side of the chassis under the damper/output tube, and goes to a terminal strip and hash choke L502.) **R-E**



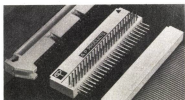
INSTANT.

The way you check line-by-line with an A P Intra-Switch or Intra-Connector.

You plug your Intra-Switch in-line with standard socket connectors, and instantly you've got a separate, independent on-off switch for each and every line in your flat ribbon cable. To switch, you nudge with a pencil point. It's that quick.

Imagine how much time and trouble Intra-Switch will save you in your diagnostic and quality testing, your programming and selective line inhibiting.

Or, plug in your Intra-Connector (see box) the same way, and you have an extra set of male contacts



at right angles. Instant line-by-line probeability—and an easy way to tap your system and daisy chain it into new areas.

Both Intra-Connectors and Intra-Switches come in 20, 26, 34, 40 and 50-contact models.

Where? At your nearby A P dealer. Where's that? Phone (toll-free) 800-321-9668. And ask for the complete A P catalog, The Faster and Easier Book.



A P PRODUCTS INCORPORATED

Box 110B • 72 Carwin Drive
Painesville, Ohio 44077
Tel. 216/354-2101
TWX: 810-425-2250

Faster and Easier is what we're all about.

To get your component speaker catalog and construction plans package, just send \$1.00 to Electro-Voice Component Speaker Systems, 600 Cecil St., Buchanan, MI 49107.



600 Cecil Street, Buchanan, Michigan 49107

DE 2.75

Class	State	Year
...


DATA PRECISION

DIGITAL MULTIMETERS



\$169.

8020A

- 26 Ranges—5 Functions plus New Conductance Function for up to 10,000 M Ω Leakage Measurements
- Extensive Overload and Transient Protection
- Rugged Construction—1 Year Warranty
- Hi/Low Power Ohms for In-circuit Resistance and Diode Testing
- 10 M Ω AC/DC Input Impedance Doesn't Load Circuit
- 200 Hour, 9V-Battery Life—Low Battery Indicator
- Large LCD Readout—2000 Counts
- 1 Year Calibration Cycle—Only 3 Adjustments
- One Hand Operation
- Complete with Battery and Test Leads

The 8020A has been designed with the user in mind and features exclusive one-hand operation. For harsh service environments, the 8020A has a ruggedized case and extensive overload/transient protection backed up by a 1-year warranty. Long term stability (1-year calibration cycle) is excellent with only three cal adjustments. Up to 200 hours of continuous operation can be expected from a single 9V alkaline battery.

BASIC SPECIFICATIONS

	DE Volts	AC Volts	DC Current	AC Current	Ohms	Conductance
Range	0.2-1000V	0.2-750V	0.002-2A	0.002-2A	200Ω-20 MΩ	200 nS-2 nS
Resolution	100 μV	100 μV	1 μA	1 μA	0.1Ω	0.1 nS
Accuracy*	(±2.5 + 1)	(±3.75 + 2)†	(±7.5 + 1)	(±1.5 + 2)†	(±2 + 1)†	(±3 + 1)†

LEADER
Instruments Corp



\$279.⁹⁵

Regular price \$319.

LCR-740

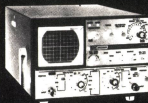
Transistorized LCR Bridge

- Highly accurate 3 digit readout.
- Measures Inductance (L), Capacitance (C) and Resistance (R), within $\pm 0.5\%$ accuracy.
- Range expandable — built-in 10% over range.
- Loss Factor scale (D).
- Battery or AC adapter operation.

NEW YEAR'S SPECIALS

Prices do not include shipping. Sale ends Feb. 28, 1979

New 15MHz portable 3" dual-trace scope

MODEL
1432

- 50MHz bandwidth with smooth roll-off: wideband response extends beyond 30MHz
- Zero-drift, vertical sensitivity
- Operates at 117VAC, 234 VAC, 120VAC or optional internal battery pack
- Fully regulated high- and low-voltage supplies
- Algebraic addition and subtraction of Channel A and B input signals
- Nineteen calibrated sweep ranges cover 0.01 microseconds to 0.01 seconds
- TTL Compatible 2-axis input
- Compact size: measures only 6.5 x 4.25 x 14.25"
- Includes two sim-probe 10:1 dividers



5MHz Solid State 3" Oscilloscope

MODEL
1403A

- 60 MHz with high sensitivity
- For production lines, schools, field service work, homecare
- 20 modulation monitor
- Ultra-compact and lightweight, goes anywhere!
- Use the 100A to release more expensive scopes for monitoring applications
- Vertical sensitivity of 10mV/division
- High brightness CRT and

\$209.⁹⁵

Regular price \$250.



R-K PRECISION

MODEL
2810

\$109.⁹⁵

Regular price \$130.

- It's light easy to read LED display
- 0.5% DC accuracy typical
- 100V, 400V resolution
- 10 phase range and control to zero lead resistance
- Selectable High/Low power phase on four ranges
- Built-in resolver
- Completely overload protected on all 20 ranges
- 100% over-range leading to 2000 counts full scale
- Protected against RF interference
- Completely portable

P-K PRECISION

\$639.⁹⁵

Regular price \$840.

MASTERCARD
VISA

THE TEST EQUIPMENT SPECIALISTS

TOLL FREE HOT LINE
800-223-0474

54 West 45 Street, New York, N.Y. 10036 212-687-2224

ADVANCE ELECTRONICS

observe that signal in any subsequent node. However, in this circuit (if R3 is not at ground) there is a signal at the left side of R234, but the right side of R234 shows just 0 volt.

This phenomenon is called a *virtual ground*. The input impedance of IC204 (as seen from the wiper of R3) is simply R234. For any signal from R3 that might attempt to pass back through R235, it's as if the right side of R235 were grounded. Turning up the sensitivity control on the scope may reveal a very severely clipped remnant of the signal. However, the output of IC204 is the original signal with a gain of R237 divided by R234.

In addition, there is a DC level that is the voltage at the left of R233 times R237 divided by R233. In this case, the voltage should be zero since R233 provides the offset null of IC204. Front-panel DC offset is applied through R235.

Resistor R236 is necessary for frequency compensation. OP-amp IC204 is internally compensated to be stable at gains greater than 10 (the gain being determined by the ratio of feedback resistor R237 to input resistors R234, etc.). Resistor R236 can be calculated, but is most easily determined empirically. Substitute

a variable resistor for R236, set S5 to the squarewave position, observe the output of IC204, and adjust R236 for both minimum risetime and minimum overshoot at 1 kHz.

Resistor R4 is the front-panel DC offset. With S9 in the SWEEP position, the R4 output mixes with the signal from R3 to provide a ± 5 -volt DC offset of that signal.

Switch S9 provides the manual timebase mode. With S9 in the SWEEP position, the triangle-wave output of the oscillator is used to sweep the frequency of the audio sweep generator as well as the timebase of an X-Y display. Setting S9 switch to the MANUAL position opens the direct connection between R4 and IC204. The triangle wave is removed from its sweep function, and R4 is substituted for it—both for the sweep circuitry and for the timebase output. Switch S5 must be in the TRIANGLE position. Resistors R209 and R206 adjust the output of IC204 so that the signal from R4 that arrives at the upper half of S9 will exactly replace the triangle wave at switch S9.

The LM377 IC has both overcurrent and thermal shutdown. It can apply at least ± 5 volts to a less than 10-ohm load. If a higher signal or power level is required, an LM378 or an LM379 can be substituted, as these IC's are equivalent.

The LM377 is rated at a total supply voltage of 26. The LM378 and LM379

are both rated at 35 volts. The only way to differentiate between those devices that can tolerate a higher voltage from those that can't is to experiment. (The premium price of the LM377 pays for destroying a lot of good LM377's to locate some of the higher voltage units we need.) The LM379 is an LM378 with a metal heat sink on top. A tab at each end lets you solder it into a circuit board; the device is also drilled and tapped so that you can mount an additional heat sink or mount the unit to a chassis.

Although the LM377 is quite immune from self-destruction, it can be damaged by applying a large external voltage at J1. Overvoltage sensor OV201 protects the output of IC204 from external damage. If ± 10 volts or more is applied to the output terminal, OV201 shorts to ground and prevents the external voltage from reaching IC204. If this voltage is present for any significant time, F201 blows, thereby protecting OV201 from excess dissipation.

The external overvoltage protection is optional. There are several devices on the market designed to limit voltage, and the PC board is set up to accept several different types. The recommended LA10 device costs approximately \$20. Even though this \$20 is there to protect a \$3 output amplifier, the value lies in eliminating repair costs and downtime.

Resistor R299 establishes the output impedance. The jumper around R299 is on the circuit board. Normally, R299 is omitted in which case the output impedance is less than 1 ohm. If some other output impedance is desired, it is inserted as R299 and the jumper on the board is cut. The jumper is on the reverse side of the board readily accessible in a finished unit, which makes it easy to attach R299.

Timebase calibration

Connect a reasonably well-calibrated oscillator scope to J1. (The scope is the only calibration standard that will be used and it is assumed that amplitude calibrations are not critical.)

- Set the scope input to DC.
- Set all trimming resistors to their center positions.
- Turn on master power switch S1 and S2.
- Set S5 to TRIANGLE and S8 to NOT INVERT.
- Set R3 to maximum and R4 to 0.
- Set S3 to 1 kHz.
- Set S4 to symmetrical.
- Set R1 to lower position.
- The output should show a clean triangle wave at about 1 kHz.
- Set R3 to zero.
- Make sure that R4 is at 0.
- Adjust R232 for zero offset.
- Set R3 to maximum.
- Adjust R227 for 16 volts peak-to-peak.
- Adjust R240 for zero offset.
- Switch S5 to squarewave.
- Adjust R224 for 16 volts peak-to-

This is easy- anyone can solder- WITH KESTER SOLDER

**KESTER
SOLDER**



Handymen! Hobbyists! DO-IT-YOURSELFERS!

Let Kester Solder aid you in your home repairs or hobbies. For that household item that needs repairing — a radio, TV, model train, jewelry, appliances, minor electrical repairs, plumbing, etc. — Save money — repair it yourself. Soldering with Kester is a simple, inexpensive way to permanently join two metals.

When you Solder go "First Class" — use Kester Solder.

For valuable soldering information send self-addressed stamped envelope to Kester for a FREE Copy of "Soldering Simplified".



KESTER SOLDER

Lifton 4201 WRIGHTWOOD AVENUE/CHICAGO, ILLINOIS 60639

peak.

Adjust R225 for zero offset.

Switch S5 to sinewave.

Adjust R223 for approximately 16 volts peak-to-peak and R222 for approximately zero offset. Both these resistors will be readjusted later.

Switch the scope input to AC.

Adjust R212 for slight clipping.

Adjust R213 for symmetrical waveform.

With the scope set to AC, adjusting R213 will cause the average level of the waveform to shift; therefore, symmetry is achieved when the positive-going and the negative-going peaks are exactly the same distance from the center line on the scope.

Adjust R212 for minimum sinewave distortion. A sinewave plotted on the face of the scope can greatly assist in this. Use an 8 × 8-centimeter overlay, and a harmonic distortion analyzer can be used if one is available.

Adjust R223 for 16 volts peak-to-peak.

Switch the scope input to DC.

Adjust R222 for zero offset.

Set S5 to triangle wave.

Check the waveform quality at each position of S3.

At the 10K position, the waveform will be distorted; however, the 10K position is only intended to trigger the pulse generator. When you initially check the low-frequency ranges, set R1 to 100 F. Any deviation from strict linearity indicates a leaky capacitor. A slight curving of the

waveform is acceptable for most applications. However, if curving is severe, the circuit may not oscillate at all at low currents. For the lowest positions of S3, set the horizontal timebase of the scope to external; this will produce just a vertical trace. Then, follow the oscillator through at least a couple of cycles to insure there is no excessive leakage. At the 0.002 setting of switch S3, a single cycle is approximately 8 minutes. If the scope beam stops while approaching one peak, increase R1 slightly. This increases the charging current. The beam should continue slightly, which indicates excessive leakage. Increasing R1 past some point should cause the oscillator to restart.

Replace the capacitor that is leaky.

Then,

Set R3 to maximum.

Set S9 to manual.

Set R4 to zero.

Set R206 for zero output.

Move R4 to +5 volts.

Set R209 for a +8-volt output.

Move R4 to -5 volts.

The output should be approximately -8 volts. Resistors R206 and R209 will be fine-tuned later on.

The combination of 50K (R3) and 16K (R234) produces a taper similar to the audio taper in most controls.

That's it for now. Next month, we'll cover the pulse generator, sweep shaper and audio sweep generator.

R-E

in portable multimeters, compare our features, our quality, our price!

Analogue, LED, and LCD—SOAR has the battery-operated multimeters for your application: the engineering and test lab, the field service technician, the small repair shop, and the radio hobbyist. Just take a look at some of the features of our instruments.

ME-221 ANALOG MULTIMETER

It's drop-proof—the taut band absorber shocks to 50 G's, and the meter movement is made in the U.S.A. Rugged and versatile, this multimeter has no equal at our price—\$30.00



ME-521DX DIGITAL MULTIMETER

This truly portable (12.7 oz.) 3½-digit LED precision instrument has a HI-LO switch for all ranges, five function modes, and an accuracy of 0.5% (typical). Price—\$115.00



ME-523 DIGITAL MULTIMETER

For the price, this is the best multimeter on the market today. It presents the function mode right on the LCD display, has a HI-LO switch for all ranges, an extremely long battery life, and an accuracy of 0.25% (typical). And all this for a price of \$150.00



And let's not forget our workhorse ME-522. It has almost all the features of the 523, but at an even lower price—\$135.00

Contact us TODAY for more details on SOAR's portable multimeters—and why not also inquire about our complete line of bench-type, tilt view DMM's.



SOAR ELECTRONICS (U.S.A.) CORP.
813 2ND STREET
RONKONKOMA, NEW YORK 11779
TEL. (516) 981-6444/TELEX 144638

ELCETRONICS LOGIC PROBE

\$19.95

DOES IT ALL!

- ALL MODE ADAPTABILITY
- FULL INSTRUCTIONS



- TAKES POWER FROM CIRCUIT
- POLARITY PROTECTED
- NO OTHER TEST EQUIPMENT NEEDED

FEATURES:

- HI/LO PULSE (SONS)
- SHORT OR OPEN MEMORY DETECTION
- 3 FOOT CORD
- NO QUESTIONS GUARANTEE
- IMMEDIATE SHIPMENT

COMPLETE
EASY
ASSEMBLY

KIT \$14.95

ELCETRONICS

P.O. BOX 2522r

PADUCAH, KY. 42001 Ph.502/442-7940

CIRCLE 57 ON FREE INFORMATION CARD

CIRCLE 35 ON FREE INFORMATION CARD

B&K-PRECISION's

new digital probe offers more than logic



Model
DP-50

- Reveals pulse presence to 50MHz
- Priced at only \$50
- Multi-family, compatible with TTL, DTL, RTL, CMOS, MOS, and HiNIL
- Clearly displays in-circuit logic activity
- Memory mode to "freeze" pulse display
- Pulse mode to "stretch" short pulses
- 2 megohm input impedance
- Typically detects pulses to 10 nanoseconds
- Overload and reverse polarity protected

The new B&K-PRECISION DP-50 50MHz digital probe simplifies the troubleshooting and analysis of all digital circuits by clearly displaying in-circuit logic activity and pulse presence.

This compact instrument includes every important logic probe feature and more. Three bright LED indicators display pulse presence and high- and low-logic states. Unlike ordinary logic probes, the DP-50 digital probe will continue to indicate pulse presence to 50MHz.

Available for immediate delivery at your local distributor.

BK PRECISION
DYNASCAN
CORPORATION

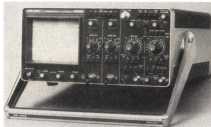
6460 West Cortland Street
Chicago, Illinois 60635 • 312/889-9087
In Canada: Atlas Electronics, Ontario

CIRCLE 56 ON FREE INFORMATION CARD

new products

More information on new products is available from manufacturers of items identified by a Free Information number. Free Information Card is inside the back cover.

DUAL-TRACE 100-MHz SCOPE, model PM3262, is a dual-channel, 100-MHz instrument that provides both a main timebase and an alternate timebase to display trigger signals simulta-



CIRCLE 120 ON FREE INFORMATION CARD

neously. Offers a 5- to 10-mv-per-division sensitivity, rectangular CRT with internal graticule, pushbutton-selectable trigger modes, X10 magnification, $\pm 3\%$ accuracy, and X-Y operation. Unit operates on 140 VAC; 200-264 VAC, 440 Hz; and 250 VDC. It comes with probes, filters, cover, adapters, and manual, with other optional accessories available. The model PM3262 measures 12.5 X 6.1 X 16.2 in., weighs 21.1 lb., and costs \$2345.—Philips Test & Measuring Instruments, Inc., 85 McKee Drive, Mahwah, NJ 07430.

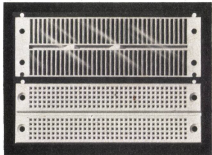
DUST REMOVER *Micro-Duster*, uses nonflammable, nontoxic filtered compressed gas to remove lint, dust, oxide particles, etc., from delicate instruments. Suggested applications include audio components, computer tapes and heads, timepieces, camera lenses and other optical de-



CIRCLE 121 ON FREE INFORMATION CARD

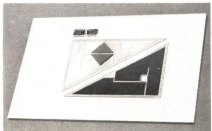
vices. *Micro-Duster* produces over 1800 one-second bursts (25-30 minutes continuous dusting) in a single can. It comes with a 6-inch extension tube; for hard-to-reach areas, *Vibra-Jet* attachment provides extended range. Comes in 15-oz. cans with a suggested retail price of \$2.50. Available only through Chemtronics distributors.—Chemtronics, Inc., 45 Hoffman Ave., Hauppauge, NY 11787.

SOLDERLESS BREADBOARD COMPONENTS, *Quick Test* (QT) sockets and bus strips, are spring-clip arrays behind a series of small holes on a molded plastic surface that can accommodate AWG Nos. 22-30 wire sizes. Sockets comprise 5-tie-point spring-clip terminals on either



CIRCLE 122 ON FREE INFORMATION CARD
side of a 0.3-inch channel, and can be used either alone or ganged with jumper leads for larger arrays. Bus strips contain twin rows of interconnected tie-points to provide 35, 47 or 59 tie-point terminals. The sockets come in 7 lengths with from 14 to 118 terminals; the bus strips measure from 4.1 to 6.5 inches long, with twin buses of 35, 47, 59 tie points each. Prices: QT sockets, \$3-\$12.50; bus strips, \$2-\$2.50.—Continental Specialties Corp., 70 Fulton Terrace, New Haven, CT 06509.

ADVANCED DRAFTING AID, *Paramatic Drafting Set*, is designed for technical designers and requires no T-square or parallel bar. The set consists of a vinyl-covered drafting board with



CIRCLE 123 ON FREE INFORMATION CARD
two 11-inch clear nylon triangles, each locking into a precise horizontal or vertical position on

the board. Also contained is a *Paramatic Line Guide* to permit drawing horizontal parallel lines without moving the triangle from position. *Paramatic Drafting Set* with 13-inch by 21-inch board costs \$45; with 20-inch by 26-inch board, \$85.—*Design Instrument Mfg. Co., Inc.*, 9849 Belfast Dr., Garden Grove, CA 92644.

COMPUTER GAME, Merlin, offers 6 games of chance for 1 or 2 players from age 7 to adult. Games range from simple "Tic-Tac-Toe" to advanced "Mindbender." The unit uses a TI micro-processor with 2K-byte memory and a battery



CIRCLE 124 ON FREE INFORMATION CARD

operated. *Merlin* can counter moves with its own strategy, and uses electronically synthesized sounds to communicate wins and losses. Approximate retail price, \$33.—*Parker Brothers*, 50 Dunham Rd., Beverly, MA 01915.

For
faster
service

USE
ZIP
CODE

on
all
mail

INTERNATIONAL FM-2400CH

FREQUENCY METER FOR TESTING MOBILE TRANSMITTERS AND RECEIVERS

• Portable • Solid State • Rechargeable Batteries

The **FM-2400CH** provides an accurate frequency standard for testing and adjustment of mobile transmitters and receivers at predetermined frequencies.

The FM-2400CH with its extended range covers 25 to 1000 MHz.

The frequencies can be those of the radio frequency channels of operation and/or the intermediate frequencies of the receiver between 5 MHz and 40 MHz.

Frequency stability: $\pm 0.0005\%$ from $+50^\circ$ to $+104^\circ\text{F}$.

Frequency stability with built-in thermometer and temperature corrected charts: $\pm 0.0025\%$ from $+25^\circ$ to $+125^\circ$ (.000125% special 450 MHz crystals available).

- Tests Predetermined Frequencies 25 to 1000 MHz
- Extended Range Covers 950 MHz Band
- Pin Diode Attenuator for Full Range Coverage as Signal Generator
- Measures FM Deviation

FM-2400CH (meter only) Cat. No. 035320	\$595.00
RF crystals (with temperature correction)	24.90 ea.
RF crystals (less temperature correction)	18.90 ea.
IF crystals	catalog price

Write for catalog



WHERE ELSE
BUT DAVIS?

600 MHz Mini Counter at \$149⁹⁵!

All Davis Frequency Counters deliver highest quality at low cost. But Series 7200 plug-in or battery-powered Mini Counters are truly minimal cost, general purpose instruments that sacrifice no basic performance characteristics. No other counter offers such superior features at Mini Counters' prices. One year warranty on assembled units, 90-day on kit components.

- 2 MODELS:** Kit \$149.95 Assembled \$199.95
- All Metal Cabinet
 - 8 Digit .4" LED Display
 - Crystal Time Base (1 ppm after cal.)
 - 115 V or 12 V operation
 - Selectable Gate Times, .1 & 1 sec.
- OPTIONS:** Portable w/Ni-Cad Battery (Built-in Charger) \$39.95
Crystal Oven (1 ppm 10 to 50°C) \$39.95 Handle \$5.00

Order direct from factory. Add \$3.00 for shipping, \$1.00 extra for C.O.D., and 7% sales tax in N.Y. State. Payment by certified check, money order, Master Charge, VISA. Credit-rated company P.O. accepted. Money back guarantee if returned in good condition in 10 days. Kits returnable only unassembled.

For more information, request **FREE DESCRIPTIVE LITERATURE**, or for in-depth preview, send \$3.00 for 32-page **INSTRUCTION MANUAL**. Detailed, illustrated. Credited against purchase of either unit.

DAVIS

DISTRIBUTOR INQUIRIES INVITED
Affordable quality is the Davis difference.

DAVIS ELECTRONICS

636 Sheridan Drive, Tonawanda, N.Y. 14150 • 716/874-5848

CIRCLE 64 ON FREE INFORMATION CARD

INTERNATIONAL CRYSTAL MFG. CO., INC.
10 North Lee / Oklahoma City, Okla. 73102
CIRCLE 60 ON FREE INFORMATION CARD

Read about The Newest, Most Exciting



The GD-1186 Digital Readout Electronic Scale shows you your weight in bright easy-to-read digits to eliminate guessing and interpolating. It uses an advanced strain-gauge transducer for outstanding precision just like expensive laboratory scales.

The GR-2001 Computerized Programmable Color TV lets you select a complete evening's viewing, then just sit back and relax. Changes channels automatically, it can even rotate your TV antenna!



Two new FCC-approved linear amplifiers add plenty of power to your Amateur Radio station. Choose from 1 kW or a hefty 2 kW to really get your signal out!



new

Exciting 2-Meter Amateur Radio Gear includes a new hand-held transceiver with minimum 2 watts out and 600 kHz offsets, and our famous HW-2036A, the mobile 2-meter industry standard.



The ID-4001 is the first totally computerized digital personal Weather Station that tells you indoor-outdoor temperature, wind chill, wind speed and direction, barometric pressure and more. Stores and retrieves info, too!



new

The OC-1401 Aircraft Navigation Computer gives you full on-board computer power right in your hand. Helps you compute important flight data for safer and more efficient flight planning. Accepts and computes data for up to nine different flight legs.



Our low-priced IO-4205 is the ONLY DC-5 MHz oscilloscope we know of that offers DUAL-TRACE versatility for sophisticated measurements!



The finest oscilloscope we've ever offered gives you DC to 35 MHz response with DUAL-TRACE and DELAYED SWEEP — it's the one you can use for virtually all electronic measurement and design work. Compares to scopes costing twice as much.



new

We've got the Personal Computer System you need, with the software support for any application you wish to program. Our "total" design computer systems include both 8-bit and 16-bit units with a full line of peripherals, accessories and floppy disk storage. With full documentation and optional software.



new

The new WH14 Line Printer provides the top value "hard copy" print-out of your computer programs.

Heathkit stereo equipment is famous for fine sound reproduction and outstanding specifications. Our new rack-mount series of stereo components continues this fine tradition. A sophisticated new stereo amplifier, digital readout tuner and graphic output indicator are available now. A super preamp and a handsome new rack are coming soon. And we have a complete line of stereo speakers to complement them.



new

Choose from these and nearly 400 other quality, money-saving electronic kits for your home, your hobby, or your business.

Catalogs are also available at Heathkit Electronic Centers Coast-to-Coast (Units of Schlumberger Products Corporation) where Heathkit products are displayed, sold and serviced. See the white pages of your phone book.

FREE

HEATHKIT® CATALOG



Building a Heathkit product can be great family fun and an education in electronics at the same time. And you'll have a top-performing piece of electronic equipment at a low price!



**Send for your
FREE Copy Today!**

**If card or coupon
is missing, write:
Heath Company, Dept. 020-500
Benton Harbor, Michigan 49022**



HEATH
Schlumberger

Heath Company, Dept. 020-500
Benton Harbor, Michigan 49022

Please send me my FREE Heathkit Catalog.
I am not currently receiving your catalogs.

Name _____

Address _____

City _____ State _____

CL-684 Zip _____

**FREE
CATALOG!**

Put Professional Knowledge and a
COLLEGE DEGREE
in your Electronics Career through

**HOME
STUDY**



**Earn Your
DEGREE**

by correspondence, while continuing your present job. No commuting to class. Study at your own pace. Learn from complete and explicit lesson materials, with additional assistance from our home-study instructors. Advance as fast as you wish, but take all the time you need to master each topic. Profit from, and enjoy, the advantages of directed but self-paced home study.

The Grantham electronics degree program begins with basics, leads first to the A.S.E.T. degree, and then to the B.S.E.T. degree. Our free bulletin gives complete details of the program itself, the degrees awarded, the requirements for each degree, and how to enroll. Write for *Bulletin R-79*.

Grantham College of Engineering
2500 S. Laciniega Blvd.
P.O. Box 33499
Los Angeles, CA 90035

Worldwide Career Training thru Home Study
CIRCLE 17 ON FREE INFORMATION CARD

★ **FREE!** ★



**NEW CATALOG OF
HARD-TO-FIND
PRECISION TOOLS**

Jensen's new 152-page catalog is jam-packed with more than 3000 quality items. Your single source for hard-to-find precision tools used by electronic technicians, scientists, engineers, instrument mechanics, schools, laboratories and government agencies. This popular catalog also contains Jensen's world-famous line of more than 40 tool kits. Plus 10 pages of useful "Tool Tips" to aid in tool selection. Send for your free copy today!

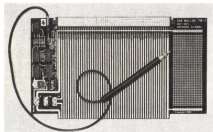
JENSEN TOOLS & ALLOYS
1230 SOUTH PIERCE DRIVE • TEMPE, AZ 85281

CIRCLE 4 ON FREE INFORMATION CARD

computer products

More information on new products is available from manufacturers of items identified by a Free Information number. Free Information Card is inside the back cover.

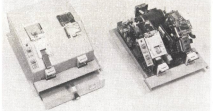
S-100 BUS EXTENDER BOARD KIT, model TB-2, is an S-100 bus-compatible card with several new features: A built-in logic probe with 7-segment display; a pulse catcher with LED; and a "kluge board" (with holes on a 0.1-inch grid) that aids in



CIRCLE 113 ON FREE INFORMATION CARD

assembling debug or test circuits. Power is provided by an on-board 5-volt regulator. Other features include power-supply links for current measurement and independent supply switching; edge connector label; and gold-plated edge connectors. List price, \$35.—**Mullen Computer Products**, Box 6214, Hayward, CA 94545.

8-LEVEL READER/PUNCH is equipped with a serial interface that operates with a standard acoustic coupler or an RS-232-compatible interface. The serial interface converts reader contact inputs and punch solenoid outputs to RS-232 levels and ASC11 codes computer hookup. The



CIRCLE 114 ON FREE INFORMATION CARD

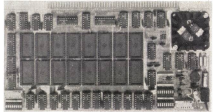
unit can also be used as a remote paper-tape terminal. Applications include typesetting, numeric control, program paper tape loading and paper tape generation/duplication. Parallel interface version is also available. Prices: serial version, \$895; parallel version \$695.—**NCE/Computer**, Box 8610, Ann Arbor, MI 48107.

COMPUTER SOFTWARE is packaged on mini-diskettes in North Star format, ready for implementation in any S-100 8080/280 system. The applications programs include: financial, mathematical analysis, statistical and miscellaneous,

games (including Trap, Taxman, Calendar, Civil-war, Lunar Lander), backdoor and mailing list (using disc data files), plus North Star DOS for Centronics printer (retail sales reporting and profile, both using disc files). Price: \$35 each.—**MicroAge Mail Order**, 1425 W. 12th Place # 101, Tempe, AZ 85281.

CIRCLE 115 ON FREE INFORMATION CARD

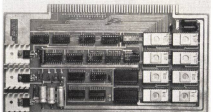
MEMORY BOARD, 32K Bytesaver, comes assembled or in kit form, and is compatible with the S-100 bus and with System Two and System Three computers. The board contains a 2716 PROM programmer, compatible with Intel 2716 PROM's or equivalent. Fast data storage is implemented by a single write into an erased PROM. The board also provides a 32K-byte ROM capability. Switches are provided to protect and



CIRCLE 116 ON FREE INFORMATION CARD

unprotect ROM's, shadow ROM sockets, select card addresses and control Bank-Select or DMA I/O features. Prices: 32K Bytesaver, kit, \$195; assembled, \$295.—**Cromemco, Inc.**, 280 Bernardo Ave., Mountain View, CA 94040.

S-100 BUS PROM BOARD, model 8K Plus 2, is available in kit form (plus sockets) or fully assembled. The board is designed for use with eight 2708 EPROM's, and has two provisions for either 2716's or pin-compatible 8316 ROM's. The board's circuitry can pull Ready-Line low for use with low-speed ROM's, and three extra 16-pin



CIRCLE 117 ON FREE INFORMATION CARD

pads are included for TTL PROM's, power-on jump, etc. The board is made of epoxy glass with solder-tinned pads and buses and gold-plated edge connectors. Prices: kit, \$59.95; assembled, \$109.95.—**Mini Micro Mart**, 1618 James St., Syracuse, NY 13203.



FREE

NATCAM catalog

Shopping center for small and precision tools

A fine selection of small tools, measuring instruments, hard-to-find items for shop, home and lab. Convenient one-stop shopping for technicians, engineers, craftsmen, hobbyists. Major credit cards accepted, satisfaction assured. Get your NATCAM catalog today.

National Camera, Inc.
2000 West Union Ave., Dept. GBF
Englewood CO 80110 USA

CIRCLE 5 ON FREE INFORMATION CARD

FREE SWTH CATALOG

Audio—Computers
Instruments
Kits & Assembled



**COMPUTER
PRODUCTS
CATALOGUE**

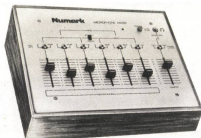
Southwest Technical Products Corporation
219 W. RHAPSODY
SAN ANTONIO, TEXAS 78216

CIRCLE 68 ON FREE INFORMATION CARD

stereo products

More information on new products is available from manufacturers of items identified by a Free Information number. Free Information Card is inside the back cover.

MICROPHONE MIXER, model MX3000, is a sound-studio unit designed to handle any high-power amplifier without using external preamp. It has provisions for 6 mike inputs and 2 stereo line inputs. Other controls include individual mike attenuators, and stereo/mono switches, a master control switch and headphone monitor. Spec-



CIRCLE 109 ON FREE INFORMATION CARD

ifications are: input sensitivity (mike), 0.5 mV, (line) 65 mV; output impedance, 100 ohms; hum and noise (mike), -52 dB, (line) -65 dB; frequency response (mike) 20 Hz-18 kHz (1 dB); (line) 10 Hz-30 kHz (-1 dB). The unit measures 12 1/2" W x 9 1/4" H x 3 1/2" D, and weighs 6 1/2 lb. Suggested retail price: \$149.95.—Numark Electronics Corp., 503 Raritan Center, Edison, NJ 08817.

TAPE RECORDER CARE KIT provides a flexible way to clean tape heads in hard-to-reach spots. The kit contains various plug-together plastic

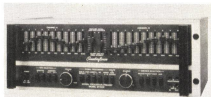


CIRCLE 110 ON FREE INFORMATION CARD

tools, a mirror, a variety of felt applicator tabs, and a bottle of tape head cleaner. Price: \$8.95.—Maxell Corp. of America, 130 Commercial Way, Moonachie, NJ 07074.

SIGNAL PROCESSOR/PREAMPLIFIER, model SP4002, contains two separate phono preamps with a 0- to 150-pF variable cartridge loading capability and a variable impedance of 100 mV at 47,000 ohms; both accept any cartridge with a 0.28- to 300-mV output capability. Each preamp contains inputs and outputs, and provides a vari-

able ± 20 -dB gain, 97-dB S/N ratio, 300-mV overload capability, plus the newly approved RIAA equalization curve. Front-panel controls include signal processing switches (including



CIRCLE 111 ON FREE INFORMATION CARD

subsonic filter, external loops, equalizer, monophonic mixer for Channels A and B and tape-record switches; volume and balance control switches; power on-off switch; and source selection switch. Built into the preamplifier unit is a graphic equalizer providing from 15-dB to 22-dB boost-per-octave and a better than 114-dB S/N ratio. Also included on the front panel are headphone jacks and an extra tape recorder jack. Price: \$699.—Soundcraftsmen, 1721 Newport Circle, Santa Ana, CA 92705.

AM/FM STEREO RECEIVER, model STR-V7, is a top-of-the-line unit that provides 150 watts-per-channel RMS into 8 ohms from 20 Hz to 20 kHz, with no more than 0.07% THD and 1% distortion. Its features include tape monitors and dubbing; stepped-attenuator volume control; bass and treble controls; high-cut and low-cut filter switches; and a loudness-compensation switch. The receiver also includes an FM bandwidth switch, linear dial calibration, flywheel coupling, FM muting switch, center tuning and signal-strength meters.

The tuner front end contains a MOSFET RF amplifier, 4-gang tuning capacitor and oscillator;



CIRCLE 112 ON FREE INFORMATION CARD

the IF stage comprises 4-element ceramic filters, a differential amplifier and 5 banks of limiters. A phase-locked-loop multiplex IC provides 48-dB at 1-kHz stereo separation. The amplifier section contains a toroidal-coil transformer and two 15,000- μ F capacitors; and the preamp features RIAA phono equalization and provides 25-mV overload protection. Suggested list price: \$820.—Sony Corp. of America, 9 W. 57th St., New York, NY 10019.

next month

■ Your Own Computer

A special section devoted to personal computing with the accent on peripheral devices, including printers, terminals and floppy discs. You won't want to miss the many hints on selecting and setting up a system and the round-up listings of peripheral devices.

■ Rechargeable Batteries—Past, Present And Future

A look at the improvements that have taken place in the last 10 years and what may take place in the next 10 years, with a special look at lithium cells.

■ Build A String Synthesizer

Part 2—Construction details for a professional-quality music synthesizer that can be built for many times less than commercially available instruments.

Want to Switch to Land Mobile Servicing?

WE CAN HELP YOU SWITCH

... by providing professional HOME STUDY training for you and your technicians. MTI has been providing specialized training in land mobile servicing for 18 years. We would like to help you also. For more information, cut out this coupon.

NO SALESMAN WILL CALL!

Name

Address

City

State/Zip A3B



Mobile Training Institute
Box 735, Camp Hill, PA 17011

CIRCLE 27 ON FREE INFORMATION CARD

THE BIG PLUS + Graphic Equalizer

ASSEMBLED
\$189⁹⁵

KIT
\$99⁹⁵



LOADED with Quality Features!

- Stereo . . . Eleven Bands Per Channel • Extremely Low Noise & Distortion • LED Peak Indicators • Center Detent ("flat") sliders • Built-in "record" Switching • Line and Microphone Level Inputs/Outputs • Regulated Power Supply • Fully Guaranteed • Horizontal or Vertical Cabinets • Kit or Fully Assembled • Plus Much, Much More!

Absolutely equals or exceeds overall performance and features of any graphic equalizer made today!

AARON-GAVIN INSTRUMENTS, INC.

17231 Corla Avenue

Tustin, California 92680

Yes! I've enclosed \$; RUSH me: ☐ cabinet ☐ send brochure

☐ assembled equalizers at \$189.95, p.p.d. ☐ Horizontal (flat) ☐ Vertical (up right)

☐ unassembled equalizer kits at \$99.95, p.p.d. ☐ Visa & Master Charge orders accepted

California residents include 6% sales tax

Name

Address

City State Zip

Card No.

Exp.

Date

Bank

No.

Dealer inquiries invited

Accuracy like a VTVM... Convenience like a VOM...

NEW BATTERY-OPERATED FET SOLID-STATE VOLT-OHMMETER #116

Easy-to-build KIT

\$44.⁷⁸

=116K

Factory-Wired & Tested

\$60.⁰⁵

=116W



Now you can get all the benefits of a VTVM (laboratory accuracy, stability and wide range) but with its drawbacks gone: no plugging into an AC outlet, no waiting for warm-up, no bulkiness. New Field Effect Transistor (FET) design makes possible low loading, instant-on battery-operation and small size. Excellent for both bench and field work.

Compare these valuable features:

- High impedance low loading: 11 megohms input on DC, 1 megohm on AC • 500-times more sensitive than a standard 20,000 ohms-per-volt VOM • Wide-range versatility: 4 P-P AC voltage ranges: 0-3.3, 33, 330, 1200V; 4 RMS AC voltage ranges: 1-1.2, 12, 120, 1200V; 4 DC voltage ranges: 1-1.2, 12, 120, 1200V; 4 Resistance ranges: 0-1K, 0-100K, 0-10 meg., 0-1000 meg.; 4DB ranges: -24 to +55DB.

Sensitive easy-to-read 4 1/2" 200 micro-amp meter. Zero center position available. Comprises FET transistor, 4 silicon transistors, 2 diodes, Meter and transistors protected against burnout. Etched panel for durability. High-impact bakelite case with handle useable as instrument stand. Kit has simplified step-by-step assembly instructions. Both kit and factory-wired versions shipped complete with batteries and test leads. 5 1/4" x 6 3/4" x 2 7/8" D. 3 lbs.

Send FREE catalog of complete EMC line and name of nearest distributor. RE-2

Name

Address

City

State Zip

EMC

ELECTRONIC MEASUREMENTS CORP.
625 Broadway, New York, N.Y. 10012

HOLD IT!

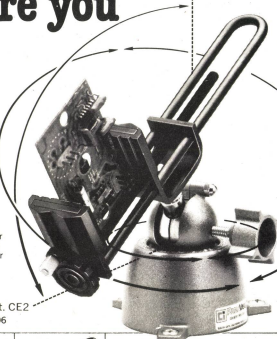
Anywhere you want it.

PanaVise tilts, turns, rotates. One quick turn of the control knob and you securely position your work exactly where you want it. Holds firmly but gently the most delicate electronic parts and P. C. boards.

Whether you're into building home electronics, trouble shooting, or professional servicing... you'll wonder how you got along without this modestly priced 'extra hand.'

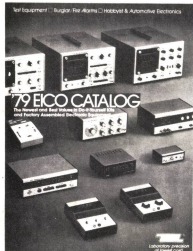
Model 396 Wide Opening PanaVise shown. An ingenious variety of other interchangeable bases, holders and accessories also available. See your electronics distributor, or write for FREE brochure.

PANA VISE® Dept. CE2
2850 29th St., Long Beach, CA 90806



CIRCLE 54 ON FREE INFORMATION CARD

The world of electronics gee-wizardry



-YOURS FREE.

32-pages of test instruments—from the latest digital multimeters to the famous EICO scopes. Security systems. Automotive and hobbyist products. Kits and assembled. EICO quality. EICO value. For FREE catalog, check reader service card or send 75¢ for first class mail.

EICO® 108 New South Road
Hicksville, N.Y. 11801

CIRCLE 26 ON FREE INFORMATION CARD



endeco soldering & desoldering equipment

SOLDERING IRONS



Pencil style. Safety light. Two heats — 20w and 40w. 6 tips. Unbreakable handle. 2 and 3 wire neoprene cords.

DESOLDERING IRONS



Pencil style. Safety light. Some operate at 40w, idle at 20w. 8 tip sizes. 2 and 3 wire neoprene cords.

SOLDERING & DESOLDERING KITS



Everything needed to solder or desolder on a handy lifetime metal box with hasp.

See your distributor or write...

Enterprise Development Corp.

5127 E. 65th St. • Indianapolis, IN 46220
PHONE (317) 251-1231

CIRCLE 29 ON FREE INFORMATION CARD

new lit

More information on new lit is available from the manufacturers of items identified by a Free Information number. Use the Free Information Card inside the back cover of this issue.

ELECTRONICS CATALOG, 48 pages of discounted items for electronics hobbyists, educators, dealers. Includes hundreds of items from basic components to TV and hi-fi equipment, a radar warning system, telephone keyboard, clock assembly, etc. Catalog also includes a 16-page wholesale supplement listing items of special interest to dealers and volume users.—**ETCO Electronics Corp.**, North County Shopping Center, Rte. 9 North, Plattsburgh, NY 12901.

CIRCLE 105 ON FREE INFORMATION CARD

BRADFORD COMPONENTS CATALOG, 8 pages listing components for servicing Bradford TV's and appliances. Included are resistors, VDR's, transistors, diodes, electrolytics, semiconductor; several parts kits are featured, as are Bradford service manuals. Price: \$1.50 (refundable with first purchase).—**The Marcel Companies**, Parts Division, 57 Enfield St., Enfield, CT 06082.

TROUBLESHOOTING GUIDE, *Common Production Soldering Problems: Causes and Cures*, is a four-page article detailing the most common soldering defects and can be used as a reference for assembly and production personnel. Some of the problems discussed are insufficient or excessive solder on joints, solder joint discoloration and solder bridges, nonwetting and dewetting conditions, measuring and cold joints. Possible causes for solder defects plus suggested solutions accompany each section.—**Multicore Solders**, Westbury, NY 11590.

CIRCLE 106 ON FREE INFORMATION CARD

QUARTZ CRYSTALS catalog contains 7 pages describing high-quality crystals for a wide variety of equipment applications—from replacement units to new, modified or experimental equipment. Crystals are available for Motorola, GE, E.F. Johnson, Comco and other manufacturers. Complete descriptions and specifications are given along with technical information for all crystal sizes and types—from microminiature to large and cold-weld varieties.—**Savoy Electronics, Inc.**, 1175 N.E. 24th St., Fort Lauderdale, FL 33310.

CIRCLE 107 ON FREE INFORMATION CARD

ELECTRONIC WIRE/CABLE CATALOG, *Catalog No. 878*, 180 pages of multi-conductor cables, computer cables, hookup wires, coax cables, wire and cable assembly packages, shielded/unshielded cords and portable cordage. Catalog includes such products as power-limited low-energy cable (UL-approved), bus-cable assemblies for IEEE-488 interconnections; and CEE color-coded wire. Construction details, specifications and electrical characteristics are given in both conventional and metric units. Price: \$2.50.—**Belden Corp.**, 2000 S. Batavia Ave., Geneva, IL 60134.

market center

CLASSIFIED COMMERCIAL RATE (for firms or individuals offering commercial products or services). \$1.50 per word (no charge for zip code) . . . minimum 15 words.

NONCOMMERCIAL RATE (for individuals who want to buy or sell personal items) 85¢ per word . . . no minimum.

ONLY FIRST WORD AND NAME set in bold caps. Additional bold face (not available as all caps) at 10¢ per word. Payment must accompany all ads except those placed by accredited advertising agencies. 5% discount for 6 issues, 10% for 12 issues within one year, if paid in advance. All copy subject to publisher's approval. Advertisements using P.O. Box address will not be accepted until advertiser supplies publisher with permanent address and phone number. Copy to be in our hands on the 26th of the third month preceding the date of the issue (i.e., August issue closes May 26). When normal closing date falls on Saturday, Sunday or a holiday, issue closes on preceding working day.

PLANS & KITS

LINEAR AMPLIFIER: Ham only 2-30 MHz, 100 watt, solid-state. **FREQUENCY COUNTER:** 300 MHz, miniportable/mobile, memory! **VOX—COMPRESSOR:** Splatter-free modulation booster. Construction plans \$3.00 each. All \$7.50! Many others, catalog with order. **PANASIX PRODUCTIONS**, Box 130-F2, Paradise, CA 95969

SCANNER users—Build many useful accessories. Free kit catalog. **CAPRI ELECTRONICS**, Route 1R, Canon, GA 30520

AMPLIFIER kits: Low TIM, Class A, Bi-FET circuitry. Free 60-page manual. **MOONLIGHTER ELECTRONICS**, 117 Inverness, San Francisco, CA 94132

CIA TOOL KIT. Complete schematics for 30 electronic surveillance devices. \$15.00. **MICRON RESEARCH**, PO Box 118, Woodstown, NJ 08098

PRINTED circuit boards from your sketch or artwork. Affordable prices. Also fun kit projects. Free details. **DANOCINTHS INC**, Box 21, Westland, MI 48185

AMAZING ELECTRONIC PROJECTS and PRODUCTS: Lasers Super Powered, Burning, Cutting, Rifle, Pistol, Pocket. See in Gant—Shotgun Directional Mike—Unscramblers—Glant Tesla—Stunwand—TV Disrupter—Energy Producing Surveillance, Detection, Electri-fying, Ultrasonic, CB, Auto and Mech. Devices. Hundreds More—All New Plus INFO UNLTD PARTS SERVICE Catalog \$1. Information Unlimited, Dept. R8 Box 718 Amherst, N.H. 03031.

SAVE 50%. Build your own speaker system. Write for catalog: **McGEE RADIO**, 1901 McGee, Kansas City, MO 64108

PROJECTION TV . . . Convert your TV to project 7 foot picture. Results equal to \$2,500 projector. Total cost less than \$20.00 Plans & lens \$16.00. Illustrated information free. **MACROMB B**, Washington Crossing, PA 18977

FOR SALE

FREE catalog (anglais). IC's, semi's. **CORONET ELECTRONICS**, 649A Notre Dame W., Montreal, Que. Canada, H3C 1H8. US inquiries.

PRINTED CIRCUIT

Positive Acting Photo Resist; Carbide bits; Bubble etchers; Artwork; Epoxy Glass Boards.

Send stamp & address label for flyer
TRUMBULL
833 Balra Dr., El Cerrito, CA 94530

RADIO & TV tubes 36¢ each. One year guaranteed. Plus many unusual electronic bargains. Free catalog. **CORNELL**, 4217-E University, San Diego, Calif. 92105

NAME brand test equipment. Up to 50% discount. Free catalog and price list. **SALEN ELECTRONICS**, P.O. Box 82, Skokie, IL 60076

SPEAKER INFORMATION KIT

Get 70 pages of speaker facts, specs, construction tips plus info on our raw speakers, crossovers and a line of 9 quality hi-fi speaker system kits. We'll send you our **full-color catalog** plus **How to Hook Up Your System**, an exhaustive step-by-step treatise on hi-fi system installation; and our **Speaker Operating Manual**, check full of facts on how to get the most from any speaker system, for Free. Even if you don't buy from us we want you to have the facts. That's how we got to be the world's largest manufacturer of speaker kits.



Send to:
Speakers, Dept. 2-RE
735 N. Northlake
Seattle, WA 98103

STAMP collectors. Fine sets of no-gum unused Canadian postage stamps. More than \$2 each value only \$1 US funds plus SASE. Quantities limited. **G. STECKLER**, 24 Straw La., Hicksville, NY 11801

Big CATALOG
Write For Your
Free Copy

TRI-TEK
incorporated

7808 N. 27th Avenue
Phoenix, Arizona 85021
(602) 995-9352

VCR's, CPU's, etching solution, and much more at discount prices. For more information send 50¢ to: **CHARLES LEWIS**, Moravia, IA 52571

Independent News Company, Inc. is pleased to announce a Retail Display Plan available to all retailers interested in earning a display allowance on Radio-Electronics magazine and who purchase the magazines from suppliers other than Independent News Co., Inc., or the publisher.

To obtain details and a copy of the formal contract please write to **Director, Retail Sales Division, Independent News Co., Inc.**, 75 Rockefeller Plaza, New York, N.Y. 10019. Under the display plan in consideration of your acceptance and fulfillment of the terms of formal contract to be sent to you upon your request you will receive a display allowance of 10% of the cover price per copy sold by you. This plan will become effective with all issues of Radio-Electronics delivered to you subsequent to the date your written acceptance of the formal Independent News Co., Inc. Retail Agreement is received and accepted by our Company.

To run your own classified ad, put one word on each of the lines below and send this form along with your check for \$1.50 per word (minimum 15 words) to:

Radio-Electronics, 200 Park Avenue South, N.Y., N.Y. 10003

ORDER FORM

PLEASE INDICATE in which category of classified advertising you wish your ad to appear. For special headings, there is a surcharge of \$10.

() Plans/Kits () Business Opportunities () For Sale
() Education/Instruction () Wanted ()

Special Category: \$10

(PLEASE PRINT EACH WORD SEPARATELY, IN BLOCK LETTERS.)

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25
26	27	28	29	30
31	32	33	34	35

AMERICA'S LARGEST SUPPLIER

of ORIGINAL Japanese Semi-Conductors

for CB, TV and Stereo Repair

We carry only genuine replacement parts

TYPE				TYPE				TYPE				TYPE			
25-UP 10-24 1-9				25-UP 10-24 1-9				25-UP 10-24 1-9				25-UP 10-24 1-9			
2SA 102	.20	.27	.30	2SC 696	1.00	1.20	1.30	2SD 234	.60	.70	.80	TA 7205P	1.60	1.80	2.00
2SA 234	.45	.53	.59	2SC 710	.20	.27	.30	2SD 235	.60	.70	.80	TA 7310P	1.30	1.45	1.60
2SA 473	.45	.53	.59	2SC 711	.20	.27	.30	2SD 261	.35	.40	.45	TBA 8105H	1.90	2.10	2.40
2SA 484	1.50	1.75	1.95	2SC 730	3.00	3.20	3.40	2SD 287	2.50	2.70	2.90	TC 5080P	5.00	5.20	5.80
2SA 495	.30	.35	.40	2SC 732	.20	.27	.30	2SD 313	.60	.70	.80	TC 5081P	3.00	3.20	3.40
2SA 497	1.00	1.20	1.30	2SC 735	.20	.27	.30	2SD 315	.60	.70	.80	TC 5082P	3.00	3.55	3.90
2SA 509	.30	.35	.40	2SC 756	1.50	1.80	2.00	2SD 325	.60	.70	.80	UMIC 002	4.20	4.40	4.90
2SA 561	.30	.35	.40	2SC 756A	1.50	1.80	2.00	2SD 427	1.80	2.00	2.25	UMIC 004	4.20	4.40	4.90
2SA 562	.30	.35	.40	2SC 781	1.90	2.10	2.40	2SD 525	.90	1.10	1.20	UMIC 005	4.20	4.40	4.90
2SA 564A	.20	.27	.30	2SC 784	.30	.35	.40	2SD 526	.60	.70	.80	UPC 20C	2.10	2.50	2.80
2SA 634	.40	.45	.50	2SC 799	2.00	2.20	2.50	FET				UPC 563	1.30	1.45	1.60
2SA 643	.30	.40	.45	2SC 828	.20	.27	.30					UPC 575C2	1.30	1.45	1.60
2SA 673	.35	.40	.45	2SC 839	.30	.35	.40					UPC 576	1.90	2.10	2.40
2SA 678	.35	.40	.45	2SC 867	3.20	3.40	3.70					UPC 592HZ	.70	.80	.90
2SA 682	.80	.90	1.00	2SC 867A	3.20	3.40	3.70	2SK 19BL	.45	.55	.60	UPC 1001	1.90	2.10	2.40
2SA 683	.30	.35	.40	2SC 897	2.00	2.20	2.50	2SK 23	.70	.80	.90	UPC 1008C	4.20	4.40	4.90
2SA 684	.35	.40	.45	2SC 930	.20	.27	.30	2SK 30	.40	.45	.50	UPC 1020H	1.90	2.10	2.40
2SA 695	.40	.53	.59	2SC 935	.20	.27	.30	2SK 33	.60	.70	.80	UPC 1025H	1.90	2.10	2.40
2SA 699A	.50	.64	.70	2SC 983	.50	.64	.70	2SK 35	.60	.70	.80	UPC 1154	2.00	2.20	2.50
2SA 706	.85	1.00	1.10	2SC 959	1.10	1.20	1.30	2SK 39	.90	1.10	1.20	UPC 1155	2.00	2.20	2.50
2SA 719	.30	.35	.40	2SC 1000BL	.35	.40	.45	2SK 40	.90	1.10	1.20	UPC 1156	1.90	2.10	2.40
2SA 720	.30	.35	.40	2SC 1014	.50	.64	.70	2SK 41	1.30	1.45	1.60	UPC 1430S	3.00	3.20	3.40
2SA 733	.20	.27	.30	2SC 1018	.60	.70	.80	2SK 45	1.30	1.45	1.60	UPD 861	8.00	8.40	9.50
2SA 747	4.20	4.40	4.90	2SC 1030C	1.90	2.10	2.40	2SK 48	3.40	3.55	3.90	UPC 857	8.00	8.40	9.50
2SA 818	.70	.80	.90	2SC 1061	.70	.80	.90	2SK 49	1.30	1.45	1.60	UPD 858	6.00	6.30	7.00
2SA 841	.20	.27	.30	2SC 1079	3.40	3.55	3.90	IC				PLL 01A	3.00	4.20	4.60
2SB				2SC 1096	.45	.55	.60					PLL 02A	5.00	5.30	5.90
				2SC 1098	.50	.64	.70					PLL 03A	7.60	8.00	8.80
				2SC 1111	2.10	2.50	2.80					DIODES			
				2SC 1124	.80	.90	1.00	AN 214Q	1.30	1.70	1.90				
2SB 22	.30	.35	.40	2SC 1128	3.20	3.60	3.95	AN 239	4.20	4.40	4.90	1S 84	.45	.55	.60
2SB 54	.20	.27	.30	2SC 1172B	.50	.55	.60	AN 247	2.50	2.70	3.00	1S 332	.35	.40	.45
2SB 75	.35	.40	.45	2SC 1173	.50	.55	.60	AN 274	1.50	1.75	1.95	1S 953	.16	.18	.20
2SB 175	.20	.27	.30	2SC 1226	.50	.55	.60	AN 313	3.00	3.20	3.40	1S 1007	.35	.40	.45
2SB 186	.20	.27	.30	2SC 1226A	.50	.55	.60	AN 315	1.80	2.00	2.25	1S 1209	.35	.40	.45
2SB 324	.30	.35	.40	2SC 1239	2.20	2.70	2.90	BA 511A	1.80	2.00	2.25	1S 1211	.35	.40	.45
2SB 337	.70	.80	.90	2SC 1306	1.30	1.45	1.60	BA 521	1.90	2.10	2.40	1S 1555	.20	.22	.25
2SB 405	.30	.35	.40	2SC 1307	1.90	2.10	2.40	HA 1151	1.50	1.75	1.95	1S 1588	.20	.22	.25
2SB 407	.80	.90	1.00	2SC 1318	.35	.40	.45	HA 1156	1.60	1.80	2.00	1S 1885	.16	.18	.20
2SB 434	.80	.90	1.00	2SC 1383	.30	.35	.40	HA 1306W	2.00	2.20	2.50	1S 2076	.20	.22	.25
2SB 435	.90	1.10	1.20	2SC 1384	.35	.40	.45	HA 1322	2.50	2.70	3.00	1S 2093	.35	.40	.45
2SB 463	.90	1.10	1.20	2SC 1419	.60	.70	.80	HA 1339	2.50	2.70	3.00	1S 2473	.16	.18	.20
2SB 473	.80	.90	1.00	2SC 1675	.20	.27	.30	HA 1339A	2.50	2.70	3.00	1N 34	.12	.13	.15
2SB 474	.70	.80	.90	2SC 1678	1.10	1.25	1.40	HA 1366	2.50	2.70	2.90	1N 60	.12	.13	.15
2SB 492	.60	.70	.80	2SC 1728	.70	.80	.90	HA 1366W	2.50	2.70	2.90	100 1	.30	.35	.40
2SB 507	.80	.90	1.00	2SC 1730	.45	.53	.59	LA 1366WR	2.50	2.70	2.90	100 10	.45	.55	.60
2SB 528B	.70	.80	.90	2SC 1760	.70	.80	.90	LA 4031P	1.80	2.00	2.25	V06B	.30	.35	.40
2SB 595	1.10	1.40	1.50	2SC 1816	1.50	1.75	1.95	LA 4032P	1.80	2.00	2.25	ZENERS			
2SB 596	1.10	1.40	1.50	2SC 1856	.50	.64	.70	LA 4400	1.90	2.10	2.40				
2SC				2SC 1908	.30	.35	.40	LA 4400P	2.00	2.20	2.50				
				2SC 1909	1.80	2.00	2.25	LA 4420	2.00	2.20	2.50				
				2SC 1945	4.50	5.00	5.60	M51513L	2.00	2.20	2.50				
				2SC 1957	.60	.70	.80	STK 011	3.80	4.00	4.40				
2SC 281	.30	.35	.40	2SC 1970	2.10	2.50	2.80	STK 013	7.60	8.00	8.80	WZ 071	.20	.22	.25
2SC 372	.20	.27	.30	2SC 1978	5.40	6.00	6.60	STK 015	4.20	4.40	4.90	WZ 075	.20	.22	.25
2SC 373	.20	.27	.30	2SC 2028	.50	.64	.70	STK 435	4.50	5.00	5.60	WZ 090	.20	.22	.25
2SC 380	.20	.27	.30	2SC 2029	1.50	1.80	2.00	TA 7045H	2.00	2.20	2.50	WZ 120	.20	.22	.25
2SC 384	.20	.27	.30	2SC 2076	.50	.64	.70	TA 7060P	.70	.80	.90	WZ 192	.20	.22	.25
2SC 458	.20	.27	.30	2SC 2091	.90	1.10	1.20	TA 7061P	.90	1.10	1.20	MISC.			
2SC 495	.45	.55	.60	2SC 2092	1.80	2.00	2.25	TA 7062P	1.10	1.25	1.40				
2SC 509	.35	.40	.45	2SC 2166	1.40	1.60	1.80	TA 7089P	2.00	2.20	2.50				
2SC 515A	.80	.90	1.00	2SD				TA 7202P	2.50	2.70	2.90	SG 613	5.20	5.40	5.95
2SC 517	2.50	2.70	3.00					TA 7203P	2.50	2.70	2.90	TBL05	.90	1.00	1.10
2SC 535	.30	.35	.40					TA 7204P	2.00	2.20	2.50	MPS U31	1.50	1.70	1.90
2SD 634A	.35	.40	.45												
				2SD 72	.50	.64	.70								

Minimum order \$5.00. Add \$1.00 postage and handling. Ask for our complete price list when ordering. Overseas buyers. Manufacturers, Distributors or Dealer orders welcome. All parts are guaranteed against factory defects for one year. C.O.D. orders are welcome. 48-hour delivery.

ORDER TOLL FREE

EAST

Nationwide 800-543-1607
Ohio 800-582-1630
Mon-Fri 10:00 to 7:00 Saturday 10:00 to 5:00
P.O. Box 40325 • Cincinnati, Ohio 45240

WEST

Nationwide 800-543-1642
California (Call Collect) 213-533-1221
Mon-Fri 9:00 to 5:00 • Sat. 9:00 to 1:00
P.O. Box 3375 • Torrance, California 90501

Telex: 21-4732

Fuji-Svea®



Active Electronic Sales Corp.

Features.....

BRAND NEW!

JUST RELEASED
1979 IC MASTER

2500
pages

Complete integrated circuit data selector. Master guide to the latest I.C.'s including microprocessors and consumer circuits.

Free Quarterly Updates **\$39.95**



Texas Instruments Low Profile Sockets

Finest Quality Socket available in the world. Nobody can match Texas Instruments quality — a unique combination of I.C. technology and multi-metal expertise.

Over one million pieces in stock.

Contacts	Price	Contacts	Price
8 PIN .08		22 PIN .22	
14 PIN .12		24 PIN .24	
16 PIN .14		28 PIN .28	
18 PIN .18		40 PIN .40	
20 PIN .20			



GENERAL INSTRUMENT

1 Amp Rectifiers (Epoxy)

1.5 Amp Single Phase

Stock level	Part No.	Price	Stock level	Part No.	Price
1.1Milion	1N4001	.029	320000	W06M	.600V .34
5Milion	1N4002	.039	110000	W08M	800V .39
1.4Milion	1N4003	.050			
1.9Milion	1N4004	.049			
3Milion	1N4005	.050			
4Milion	1N4006	.060			
1.7Milion	1N4007	.050			

SWITCHING DIODES

Part No.	Price
1N914 (100V 4NS)	.027
1N4148 (100V 4NS)	.027



Z80-CTC	\$10.90
Z80A-CTC	\$13.10

Z80-DMA	\$32.20
---------	---------

Z80-CPU	\$13.60	Z80-SIO/0	\$45.00
Z80A-CPU	\$16.20	Z80A-SIO/0	\$50.00
Z80-PIO	\$10.90	Z80-SIO/1	\$45.00
Z80A-PIO	\$13.10	Z80A-SIO/1	\$50.00

CMOS's

CD4000BE .17	CD4042BE .59	CD4515BE \$1.95
CD4001BE .17	CD4043BE .57	CD4516BE .69
CD4002BE .17	CD4044BE .55	CD4518BE .79
CD4006BE .87	CD4046BE .59	CD4519BE .47
CD4007BE .17	CD4048BE .33	CD4520BE .69
CD4008BE .75	CD4050BE .33	CD4522BE .99
CD4009BE .39	CD4051BE .54	CD4526BE .99
CD4010BE .39	CD4052BE .54	CD4527BE \$1.09
CD4011BE .17	CD4053BE .54	CD4528BE .69
CD4012BE .17	CD4056BE .89	CD4531BE .79
CD4013BE .32	CD4066BE .44	CD4532BE \$1.19
CD4015BE .13	CD4068BE .21	CD4539BE .99
CD4015BE .69	CD4069BE .21	CD4543BE \$1.39
CD4016BE .35	CD4070BE .29	CD4555BE .65
CD4017BE .62	CD4071BE .21	CD4560BE .69
CD4018BE .69	CD4072BE .21	CD4581BE \$2.25
CD4019BE .39	CD4073BE .21	CD4586BE .99
CD4020BE .69	CD4075BE .21	CD4584BE .60
CD4021BE .69	CD4076BE .79	CD4585BE .59
CD4022BE .69	CD4077BE .25	4001APC .50
CD4023BE .17	CD4078BE .21	4005PC \$1.09
CD4024BE .69	CD4081BE .21	4009PC .60
CD4025BE .17	CD4082BE .21	4009PC .60
CD4026BE \$1.39	CD4085BE .29	4010PC .89
CD4027BE .39	CD4086BE .69	4016PC .99
CD4028BE .57	CD4093BE .40	4016PC .89
CD4029BE .74	CD4104BE \$2.25	4016PC .99
CD4030BE .35	CD4503BE .85	4017APC .89
CD4033BE \$1.45	CD4508BE \$2.25	4019PC .89
CD4034BE \$2.25	CD4510BE .88	4019PC \$1.19
CD4035BE .64	CD4511BE .89	4019PC \$1.19
CD4040BE .74	CD4512BE .59	4019APC \$1.19
CD4041BE .74	CD4514BE \$1.95	4019PC \$1.10

MICROPROCESSOR

CHIPS CPU's

Stock level	Part No.	Price
4600	8080A	5.95 5.50
16000	6800	8.95 7.95

INTERFACE SUPPORT CIRCUITS

Stock level	Part No.	Price
4000	8212	1.98
1400	8214	4.95 3.95
2800	8216	1.98
1500	8224	2.75
4000	8226	1.98
1700	8228	4.75
700	8238	4.75
5800	8251	5.95 4.95
550	8253	14.95
11000	8255	5.95
400	8257	9.95
800	8259	14.95

3300	6810	3.95 3.50
2200	6820	4.95 3.95
4200	6821	4.95 3.95
3000	6850	5.95 4.95
1200	6852	5.95 4.95

LINEAR I.C.'S

LM324N	.49	Quad Op Amp
LM339N	.49	Quad Comparator
LM555N-8	.29	Timer
LM556N-14	.59	Dual Timer
LM723CN	.34	Voltage Regulator
LM723CH	.39	Voltage Regulator
LM741CH	.37	Op Amp
LM741CN-8	.24	Op Amp
LM1458N-8	.39	Dual Op Amp

VOLTAGE REGULATORS

PART NO.	UNIT PRICE	DESCRIPTION
LM323K	\$5.50	3 Amp 5 Volt Regulator
78H05KC	\$5.75	5 Amp 5 Volt Positive Regulator
7800UC Series	.79	Positive Voltage Regulators (Plastics) 1 Amp 5, 6, 8, 12, 15, 18, 24 Volts
TO-220 ILM340T		
78M00HC Series	\$1.50	Positive Voltage Regulator 1/2 Amp 5, 6, 8, 12, 15, 18, 24 Volts
TO-5 ILM340K		
7800KC Series	\$1.60	Positive Voltage Regulator 1 Amp 5, 6, 8, 12, 15, 18, 24 Volts
TO-5 ILM340K		
78L00AUC Series	.29	Positive Voltage Regulator 100 MA 2.6, 5, 6, 8, 12, 15, 18, 24 Volts
TO-92		
7800UC Series	\$1.10	Negative Voltage Regulator 1/2 Amp 5, 6, 8, 12, 15, 18, 24 Volts
TO-220 ILM320T		
7800KC Series	\$1.50	Negative Voltage Regulator 1/2 Amp 5, 6, 8, 12, 15, 18, 24 Volts
TO-5 ILM320K		
7800KC Series	\$1.95	Negative Voltage Regulator 1 Amp 5, 6, 8, 12, 15, 18, 24 Volts
TO-3 ILM320K		
78M02TC	\$1.25	Full In Line Adjustable 4 Terminal Positive Voltage Regulator
78GLU TO-220	\$1.45	1 Amp Adjustable Positive Voltage Regulator
78S40PC	\$2.50	Switching Regulator

All new major manufacturer production material offered. Largest variety of device types available anywhere.

MOS Static RAM's

Stock level	Part No.	Price
11400	2114	\$7.50
	4K (1K x 4) 300NS	
74000	2102LFC	\$1.19
	1K 300NS (Low Power)	

19700	2114	\$6.95
	4K (1K x 4) 450NS	

MOS Dynamic RAM's

Stock level	Part No.	Price
16000	4K 4027	\$2.95
	4K (4K x 1) 300NS 16 PIN	
21500	416-3	\$9.95
	200NS	
93000	416-5	\$9.95
	300NS	

UART's

Stock level	Part No.	Price
44000	AY5-1013A	\$4.95
3800	AY3-1015	\$5.95

1K CMOS RAM

Stock level	Part No.	Price
21400	5101	\$4.95
	450NS (Low Power)	

P.O. BOX 1035 FRAMINGHAM, MASSACHUSETTS 07017

Over-the-counter sales,
12 Mercer Rd., Waltham, Mass 01760
Behind Zayres on Rte. 3
Telephone Orders & Enquiries (617) 879-0077

IN CANADA 3 LOCATIONS

5651 FERRIER ST.
MONTREAL, QUEBEC
H4P 2V5
Tel: (514) 735-6425

4600 DUFFERIN ST.
DOWNSVIEW, ONTARIO
M3H 5S6
Tel: (416) 661-1115

MINIMUM ORDER \$10.00 • ADD \$2.00 TO
COVER POSTAGE & HANDLING
Foreign customers please remit payment on an
international bank draft or international postal
money order in American dollars.

BAXTER CENTRE
1055 BAXTER ROAD
OTTAWA, ONTARIO
K2C 3P2
Tel: (613) 820-9471

Active Electronic Sales Corp.

Radio Shack: No. 1 Parts Place

Low Prices and New Items Everyday!

Top-quality devices, fully functional, carefully inspected. Guaranteed to meet all specifications, both electrically and mechanically. All are made by well-known American manufacturers, and all have to pass manufacturer's quality control procedures. These are not rejects, not fallouts, not seconds. In fact, there are none better on the market! Always count on Radio Shack for the finest quality electronic parts!

TTL and CMOS Logic ICs

Full-Spec Devices
Direct from
Motorola and
National Semiconductor

Type	Cat. No.	ONLY
7400	276-1801	35¢
7402	276-1811	39¢
7404	276-1802	35¢
7406	276-1821	49¢
7410	276-1807	39¢
7413	276-1815	79¢
7420	276-1809	39¢
7427	276-1823	39¢
7432	276-1824	49¢
7441	276-1804	99¢
7447	276-1805	99¢
7448	276-1816	99¢
7451	276-1825	39¢
7473	276-1803	49¢
7474	276-1818	49¢
7475	276-1806	79¢
7476	276-1813	79¢
7485	276-1826	1.19
7486	276-1827	49¢
7490	276-1808	79¢
7492	276-1819	99¢
74153	276-1817	99¢
74145	276-1828	1.19
74120	276-1829	1.39
74154	276-1834	1.29
74192	276-1831	1.19
74193	276-1820	1.19
74194	276-1833	1.19
74196	276-1833	1.29
4001	276-2401	99¢
4001	276-2411	49¢
4012	276-2412	99¢
4013	276-2413	99¢
4017	276-2417	1.49
4020	276-2420	1.49
4021	276-2421	1.49
4023	276-2423	99¢
4027	276-2427	99¢
4028	276-2428	1.29
4046	276-2446	1.69
4049	276-2449	99¢
4050	276-2450	99¢
4051	276-2451	1.49
4066	276-2466	99¢
4070	276-2470	99¢
4511	276-2447	1.69
4518	276-2490	1.49
4543	276-2491	1.89

SN-76477 Sound/Music Synthesizer IC

299

Featured in Oct.
Popular Electronics

Creates almost any type of sound — music to "gunshots!" Built-in audio amp. Includes 2 VCO's, LF osc., noise gen., filter, 2 mixers, envelope modulator, logic circuit. 28-pin DIP. With data/applications circuits. 276-1765 2.99

Analog Audio Delay IC MN 3002

1095

For Phase-Shifter, Reverb & Delay Circuits

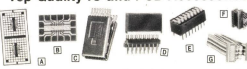
"Bucket Brigade" device uses 512 shift registers to provide a continuously variable electronic delay for complex audio signals. Includes data sheet and applications circuits. 276-1760 10.95

Heat Sinks



- TO-220. For PC board-mounted power semiconductor devices in TO-220 cases. Anodized aluminum. 79¢
- TO-3 Sink. For PC or chassis mg. 276-1363 1.39
- Universal. Mounts 2 devices, accepts 3 case styles. 276-1361 2.69

Top-Quality IC and PCB Accessories



- PC Board. Mounts ten 14 or 16-pin ICs or sockets for bread boarding. Copper clad. 276x1 1/2". 276-181 2.99
- PC Board. Mounts single 14 or 16-pin IC or socket. 276-004 2.99
- 16-Pin IC Test Clip. 276-1951 3.99
- 16-Pin DIP Header. With snap cover. 276-1980 1.99
- 8-Rocker 16-Pin DIP Switch. 276-1301 1.99
- Vertical 16-pin Socket. For LED displays. 276-1986 1.49
- 16-Pin DIP Jumper Cable. 18 long. 276-1976 3.99

Project Boxes



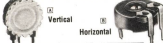
The popular, low-cost way to house your electronic experiments.

Miniature Hobby Motors



- High-torque permanent magnet type. 1 1/8" dia. shaft. 1 1/2" long. 350mA. 2x 1/4". 99¢
- 12VDC. 350mA. 2x 1/4". 99¢
- 273-210 1.49
- 6-VDC. 500mA. 1 1/8". 273-209 2.99

PC Potentiometers



	Vertical	Horizontal
Ohms	Cat. No.	Cat. No.
500K	271-238	49¢
1K	271-227	49¢
5K	271-217	49¢
25K	271-216	49¢
50K	271-218	49¢
100K	271-220	49¢
500K	271-221	49¢
Meg	271-222	49¢

Switches



- Miniature Toggle. 6A @ 125VAC. SPDT. 276-662 2.49
- DPDT. 276-663 2.89
- DPDT. Center-Off. 276-664 2.99
- Momentary SPST. 276-609 1.89
- Momentary SPST. 276-1549 1.99
- SPST Mercury. 276-027 99¢

Molded Connectors



- Molded nylon body. Each circuit rated 8A @ 250V. Standard .083 pin diameter. 99¢
- 4-Pin Male. 274-224 1.49
- 6-Pin Male. 274-226 1.39
- 9-Pin Male. 274-228 1.49
- 15-Pin Male. 274-232 1.49
- 4-Pin Female. 274-224 99¢
- 6-Pin Female. 274-226 1.19
- 9-Pin Female. 274-228 1.19
- 12-Pin Female. 274-242 1.49
- 2-Pin Male & Female. (Not Shown) 1.49

8080A Microprocessor and Support Chips

New — 100% Prime



SALE

- 8080A Microprocessor. 2 µs cycle time. 276-2510. Reg. \$12.95 Sale 9.95
- 8255 Bus Driver. 8-bit bidirectional. 276-2508. Reg. \$5.95 Sale 4.95
- 8154 128K-Bit RAM. 140-pin DIP. 276-2511. Reg. \$9.95 Sale 7.95
- 8212 I/O Port. Data latch and buffer. 276-2512. Reg. \$4.95 Sale 3.95
- 8224 Clock and Queue Driver. 276-2513. Reg. \$5.95 Sale 4.95
- 8228 System. Reg. \$3.95 Sale 2.95
- 8228 System Controller and Bus Driver. 276-2528. Reg. \$5.95 Sale 5.95
- 8251 Programmable Communication Interface. 276-2551. Reg. \$9.95 Sale 7.95
- 8255 Programmable Peripheral Interface. 276-2555. Reg. \$9.95 Sale 7.95

RAM Memory ICs

- Under 450 ns Access Time
- 2102 1024 x 1 Array. Low-cost static memory chip. 16-pin DIP. Buy 3 and save! 276-2501 2.49 Ea. or 8/14.95
- 2114L 1024 x 4 Array. NMOS static RAM. 16-pin DIP. 276-2504. Reg. \$12.95 Sale 10.95

IC Breadboard Sockets



- Modular boards snap together and feature standard 0.3" center. Accept 22 through 30-gauge solid hookup wire. 49¢
- 500 connections in 2 bus strips of 40 tie points each with 47 rows of 5 connected tie points. 2 1/2x6". 276-1714 9.95
- 270 connections in 2 bus strips of 40 tie points each with 23 rows of 5 connected tie points. 2 1/2x6". 276-1715 8.95
- Mini-Socket. 22 rows of 5 tie points each, plus 2 bus strips with 10 connections each. 2 1/2x1 1/2". 276-1776. Reg. \$3.95 Sale 2.99

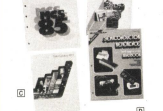
Solar Cells



- Electricity from Light
- 2 1/4". Silicon Cell
- 4cm x 2cm Silicon Cell
- Slit-type cell converts light to electrical power, delivering up to 100 mA at 0.5V. Use several in series-parallel for higher voltage or current. 276-120 2.99

- Highly efficient! Delivers up to 400 mA at 0.5V. Ideal for solar power projects, battery charging and operating electronic equipment. 276-121 5.99

Computer Data Manuals and Semiconductor Handbook



- Intel® 8080/8085 Programming Manual. Handy reference for programming with Intel's assembly language. 62-1377 3.95
- Intel Memory Design Handbook. Explains use of Intel's memory components and support circuits in systems. 62-1378 3.95
- Intel Data Catalog. 928 pages of specifications on most of Intel's standard microcomputer-related products. 62-1379 4.95
- Semiconductor Reference and Application Handbook. Complete specs and applications for popular IC transistors, diodes, 276-4002 1.95

Low-Cost Plug-In PC Boards



- For 22-pin connectors. 4 1/2x4 1/2" grid. 3 styles available. Standard. 276-152 3.49
- Digital. 276-154 3.49
- Op-Amp. 276-153 3.49
- 22-Pin Dual Connector. 276-151 2.99

WHY WAIT FOR MAIL ORDER DELIVERY?
IN STOCK NOW AT OUR STORE NEAR YOU!

Prices may vary at individual stores and dealers

Radio Shack
A DIVISION OF TANDY CORPORATION • FORT WORTH, TEXAS 76102
OVER 7000 LOCATIONS IN NINE COUNTRIES

FEBRUARY 1979

THE MOST ADVANCED TIMEPIECE OF ITS KIND IN THE WORLD!

LCD Quartz Alarm Chronograph with calendar and dual time zone! Watch is the same as Seiko but you pay a lot more for the name! Features:



- * 24 hour alarm
- * Chronograph counts up to 12 hrs, 59 mins, 59.9 sec.
- * Precision of chrono up to 1/10 sec indicated by 10 moving arrows!
- * *Last alarm with chrono running uninterrupted)
- * Time displays by LCD for hour, min, sec, day, date
- * *Calendar gives out date-day
- * *Dual time zone for any two cities of the world at your own choice.
- * *With light switch to allow you to see the time in the dark!

\$65.50

ONE YEAR FULL WARRANTY!

JUMBO 1" LED ALARM CLOCK MODULE

- Assembled - not a kit!
- Features:
- * 1" 4 digits red LED display
 - * 12 hours real time format
 - * 24 hours alarm audio output (just add speaker)
 - * Power failure indicator
 - * Count down timer 59 mins.
 - * 12-16V AC 50/60 Hz input
 - * 10 min. snooze control



\$8.50 EACH

PCH 701

Transformer

\$1.75

NEW MARK III 9 Steps 4 Colors LED VU

Stereo level indicator kit with arch-shape display panel! This Mark III LED level indicator is a new design PC board with an arch-shape 4 colors LED display (change color from red, yellow, green and the peak output indicated by red red). The power range is very large, from -30dB to +50dB. The Mark III indicator is applicable to 1 watt - 200 watts amplifier operating voltage is 3V - 9V DC at max 400 MA. The circuit uses 10 LEDs per channel. It is very easy to connect to the amplifier. Just hook up with the speaker output!

IN KIT FORM \$17.50

ELECTRONIC DUAL SPEAKER PROTECTOR

Cut off when circuit is shorted or overloaded to protect your amplifier as well as your speakers. A must for OCL circuits.



KIT FORM

\$8.75 EA.

It is not a pack of cigarettes. It is a new FM wireless mic kit! New design PC board fits into a plastic cigarette box. (case included) Uses a condenser microphone to allow you to have a better response in sound pick-up. Transmits up to 350 ft! With an LED indicator to signal the unit is on.



KIT FORM

\$7.95

AN AIR HORN!

Good for anything needing sound. This is not electronic, but we bought them with some other deals. They are all brand new in boxes. **\$2.50 EA.**



TAP-A-LINE

It is a multi-plug extension cord for 110V AC Maximum 12 plugs **\$3.50 EA.**

Mount This Side Up. Insert Plug Prongs Here



3-579 MHz Color TV Crystal

ON SALE

\$1.25 EA.

10 for \$11.00

6V 2AMP Rechargeable Battery



for moped, backup light system, alarm system, CB or other purpose. All brand new, never charged! **SPECIAL PRICE \$4.25 EA**

THE MOST POPULAR MM5314 CLOCK KIT

Features:

- * 12/24 Hours Display
- * 50/60 Hz Input
- * 6 Digits Bright Orange Readouts

Kit includes plastic case, MM

5314 I.C. One set transistor drivers, P.C. Board, gas discharge displays, all other electronic parts and transformer. Catalog no. DC-85P



SPECIAL PRICE

\$17.95 PER KIT

9 STEPS LED LEVEL INDICATOR KIT



for most stereo amplifiers
This new project works as a pair of VU meter to indicate the output level of your amplifier from -20dB to +30dB. Kit includes all LED, transistors, electronic components, P.C. Board and instructions.

Easy to build and fun to see.

ONLY \$12.50 EA.

60W + 60W



COMPLETED UNIT - NOT A KIT!

OCL pre amp. & power stereo amp. with bass, middle, treble 3-way tone control. Fully assembled and tested, ready to work. Total harmonic distortion less than 0.5% at full power. Output maximum is 60 watts per channel at 8Ω. Power supply is 24 - 36V AC or DC. Complete unit

*Kit form \$37.50

Assembled \$49.50 ea.

Power transformer

\$ 8.50 ea.

22W + 22W STEREO HYBRID AMPLIFIER KIT

It Works in 12V D.C. As Well! Kit includes 1 PC SANYO STK-024 stereo power amp. IC LM 1458 as pre amp, all other electronic parts, PC Board, all control pots and special heat sink for hybrid. Power transformer not included. It produces ultra hi-fi output up to 44 watts (22 watts per channel) yet gives out less than 0.1% total harmonic distortion between 100Hz and 10KHz. **\$32.50 PER KIT**

POWER TRANSFORMER \$4.50 EACH

WHAT A SAFE WAY TO SHOOT!

Electronic shooting game for all ages. Target uses photo electric cell and pistol shoots light beams.

Range approx. 10 ft. and target makes sound. Not a kit! Battery not included. **\$13.50 per set**



SANYO HYBRID

Audio power amplifiers I.C. Max. hi-fi output power, minimum ext. components needed.



15 Watts	STK-028	\$ 8.50
23 Watts	STK-054	\$13.50
30 Watts	STK-056	\$17.50
50 Watts	STK-050	\$26.50
10W + 10W (stereo)	STK-040	\$14.50
15W + 15W (stereo)	STK-041	\$25.50
20W + 20W (stereo)	STK-043	\$31.50

*data sheet comes with purchase

COMPUTER GRADE CAPACITORS

All capacitors are Brand New U.S. made in standard size

6000MFD	50V	\$2.60 EA.
9000MFD	50V	\$3.25 EA.
11000MFD	35V	\$3.20 EA.
14500MFD	40V	\$3.40 EA.
23000MFD	20V	\$3.00 EA.
58000MFD	20V	\$3.20 EA.
100,000MFD	6V	\$2.50 EA.

DIP SWITCHES



(On-Off Contacts)	
4 positions	\$1.50
5 positions	\$1.60
6 positions	\$1.70
7 positions	\$1.70
8 positions	\$1.80
10 positions	\$2.00

ELECTRONIC WHEEL OF FORTUNE KIT

With 10 numbers spin into black and white on dial. The LED turns when you hit the play switch, then it slows down and stops on one number. It sounds like a motor inside, but there is none. Lots of fun and easy to build. Kit comes with nice looking case, all electronic parts, P.C. Board and LEDs. Battery not included. **\$12.50**



SUPER 15 WATT AUDIO AMP KIT



ONLY \$23.50 each

63 KEYS ASCII DECORDED COMPLETE KEYBOARD

by Honeywell
with dual color key tops, uses TMS 5000 decoder LSI. (schematic data included)



SPECIAL \$56.50 NOT A KIT!

MANY SOUND DECISIONS!

Solid state sound indicator operating voltage 6V DC 30mA. A small size approximately 3" x 1 1/2". Model EB2116 (Continuous) Model EB2126 (Slow Pulse) Model EB2136 (Fast Pulse)



Continuous

Slow pulse

Fast pulse

1Watt AUDIO AMP

All parts are pre assembled on a mini PC Board Supply Voltage 6 ~ 9V D.C. SPECIAL PRICE \$1.95 ea.



"FISHER" 30 WATT STEREO AMP

Kit includes 2 pcs. Fisher PA301 Hybrid IC all electronic parts with C.B. Board, Power supply 3 1/2V DC (not included), Power band 330K, 20KHz ~ 20KHz.

Super Buy Only \$18.50



5W AUDIO AMP KIT

2 LM 385 with Volume Control Power Supply 6 ~ 18V D.C. **only \$5.00 ea.**



TIMER KIT

Time Controlled from 1-100sec. Ideal to be used as timer delay unit for burglar alarm, photo service, and other purposes. Max. loading 110V, 2 AMP. Supply voltage 12-18V DC. **\$11.50 each**



ELECTRONIC ALARM SIREN

COMPLETE UNIT Ideal for use as Alarm Unit or hookups to your car back up to make a reverse indicator. Line Output up to 3300B Voltage Supply 6 ~ 12V **\$7.50**



SOUND ACTIVATED SWITCH

All parts completed on a PC Board. SCR will turn on relay buzzer when triggered only on for 2 ~ 10 sec. (adjustable). Ideal for use as door alarm, sound controlled toys. Supply voltage 6V ~ 12V D.C. **\$1.75 ea. 2 for \$3.00**



LINEAR SLIDE POT 500KΩ SINGLE Metal Case 3" Long 2 FOR \$1.20



DIGITAL ELECTRONIC LOCK KIT

for auto ignition, entry door, burglar alarm, etc. **\$6.50 ea.** 4 Digits Programmable to Lock or Unlock. Any Combination In Circuit. **NO BATTERY REQUIRED**



BATTERY POWERED FLUORESCENT LANTERN

FEATURES

- Circuitry designed for operation by high efficient, high power, sodium halide which enable illumination maintain in a standard level even the battery supply drops to a certain low voltage level.
- 9" 6W cool/daylight miniature fluorescent tube.
- 6 x 1.5V UM-3 (size D) dry cell battery.
- 9" Hides door for 100% protection.
- Stainless reflector with wide angle increasing illumination of the lantern.

\$9.60 EACH MODEL 888 H



PROFESSIONAL CASE
for our 0.30V Power Supply. It is a nice looking metal cast case with giant 4" volt/amp meter; output blinding post and fuse holder, on/off switch and line cord! **ONLY \$21.50 EA.**

CASE 030

POWER SUPPLY KIT

0.30V D.C. REGULATED Use UA723 and 2N3055 Power TR output can be adjusted from 0.30V, 2 AMP. Complete with PC Board and all electronic parts. **\$10.50 each**
Transformer for Power Supply, 2 AMP 24V x 2 \$6.50 30V DC Panel Meter \$4.20



12V DC MINI RELAY P.C. Board Solder Type 2AMP Contact SPDT \$1.30 EA 5AMP Contact SPDT \$1.75 EA 5AMP Contact 4PD \$2.20 EA

ELECTRONIC SWITCH KIT

CONSUMER TYPE Touch Or Touch Off Use 7473 J.C. and 12V relay **\$5.50 each**



AUTO ALARM KIT

The Crimelighter Auto Alarm is an electronic self-contained auto protection system. It is mounted in the glove box of an automobile. Two minutes after turning light "off" when alarm automatically horn will sound after a 10-45 second delay interval. The alarm will sound for two minutes before automatically turning off. The alarm then resets and is ready to again protect the vehicle from unwanted entry.

FEATURES: Simple installation. 5 wires. Automatically turns on when auto is parked. Adjustable entry time. Extended time to allow for unhooked exit from vehicle. Numerous applications include protection of freight cars, trucks, boats, etc. The alarm cannot be deactivated by "hot wiring" an auto. Cannot be turned off without ignition key. Negative ground only.

ONLY \$14.00 PER KIT



4 DIGITS ALARM CLOCK

COMPLETE UNIT NOT A KIT
• 0.5" RED LED READ OUT
• 24 HRS. ALARM SET
• 10 MIN. SNOOZE SET
• AM/PM ALARM INDICATORS
• 20 SECOND DISPLAY SWITCH
• AUTOMATIC BRIGHTNESS CONTROL
• COMPACT AND HANDSOME
• 110V AC 60HZ INPUT
\$17.50 EACH



2 1/4" ROUND SPEAKER

8Ω 0.25W for most sound projects



SPECIAL 3 for \$2.00

I.C. TEST CLIPS

Same as the E 2 clips With 20" Long Leads In Black and Red Colors **\$2.75 per pair**



FM WIRELESS MIC KIT

This new Model FM wireless MIC kit uses 3 high freq. transistors, works on the FM range (88-108 MHz). It transmits the sound wave fidelity clear over long distances (up to 250 ft.). Kit comes with all electronic parts, P.C. Board and mini microphone!

\$6.95 EACH KIT

Very over long distances (up to 250 ft.). Kit comes with all electronic parts, P.C. Board and mini microphone!

WE FOUND THE CASE FOR THE FM MIC!

Small neat looking aluminum case size like a pack of cigarettes. It is an interior aluminum case, can be used for many projects. We give you instructions, data and all.

VERY SPECIAL PRICE 2 for \$4.99

Sub-Mini Size Condenser Microphone

Not a Kit FET Transistor Built-in

FLUORESCENT LIGHT DRIVER KIT

12V DC POWERED Lights up 8 ~ 15 Watt Fluorescent Light Tubes



Ideal for camper, outdoor light or boat

Kit includes: high voltage coil, power transformer, heat sink, all other electronic parts and PC Board, light tube not included!

ONLY \$5.50 PER KIT

12V D.C. AUTO DIGITAL CLOCK

Complete Unit Not a Kit



0.4" blue color 4 digits display. Turn off readouts when car is not running. Xtal controlled time base for time accuracy. Special designed case for easy mounting on top of your dashboard. Ideal for car, boat and campers.

SALE! ONLY \$24.50



HEAVY DUTY CLIP LEADS

10 pairs ~ 5 colors Alligator clips on a 22" long lead. Ideal for any testing.

\$1.85/pack

MINI-SIZED I.C. AM RADIO

Size smaller than a box of matches! Receives all AM stations Batteries and ear phone included

Only \$8.50



BRAND NEW EVEREADY CH15 AA size Ni-CD 500 MA/HR. 4 for \$5.50

Only limited quantity available



Sub Mini Size PANEL METER

500 UVA ONLY \$1.20 ea



PANEL METER (D.C. Type)

AA SIZE Ni-CD BATTERY 6 in pack 11.2V X B1 500 MA/HR \$1.80 PER PACK



TRANSFORMERS

All 117 VOLT INPUT

30V 4AMP \$7.50 EA 36V CT 3AMP \$6.50 EA 3AMP 3AMP \$6.50 EA 24V CT 3AMP \$6.50 EA 24V CT 0.8AMP \$1.80 EA 12V CT 0.8AMP \$1.80 EA 12V CT 100MA \$1.25 EA

AC POWER SUPPLY

Wall Type Transformer

12V AC Output 2000MA \$2.75 EA 12V AC Output 100MA \$2.50 EA 6V DC Output 120MA \$1.90 EA 12V DC Output 100MA \$1.90 EA



WIDE ANGLE PANEL METER

1 1/2" x 3 1/2" IMA Full scale (scale marks 0-100) **\$1.50 each**



HOUR INDICATOR

This unit is a 1 1/2" long operating unit. It will tell you how many hours your circuit or machine has been in service up to 100 hours. Limited Quantity Only \$1.75 ea.

TOGGLE SWITCH

Half size of common toggle switch 1/2" x 1/2" x 1/2" 12V AC contact

14 10-95 SPDT ON/OFF 1.75 ea 10-95 DPDT ON/OFF 1.75 ea 10-95 DPDT 1.20 1.20 1.20



SUBMINIATURES TOGGLE SWITCHES

SPDT ON/OFF 1.75 ea 10-95 DPDT ON/OFF 1.75 ea 10-95 DPDT 1.20 1.20 1.20



MINI SIZE REED RELAY

Non-polarized secure SPST Normal Open Contact rated 1AMP Coil 6 ~ 12V DC All brand new by AMF 3 for \$2.00



PUSH-BUTTON SWITCH

Color Red, White, Blue, Green, Black, 4/91-00 N.C. or N.O. Available 50 ea. LARGE QTY. AVAILABLE



SOLID STATE ELECTRONIC BUZZER

Mini size 1/2" x 1/2" x 1/2" Supply voltage 1.5V ~ 12V Ideal for Alarm or Tone Indicator **\$1.50 each**



MINIMUM ORDER \$10.00. California residents add 6% sales tax and 10% shipping. Out of state add 15% of total purchase for shipping charges. All USA and Overseas add 25% of total purchase.

12/78

SEND CHECK OR MONEY ORDER TO

FORMULA INTERNATIONAL INC.

12603 CRESHAW BOULEVARD • HAWTHORNE, CALIFORNIA 90250

For more information please call (213) 973-1921, (213) 679-5162

STORE HOURS 10:00 AM - 6:00 PM SATURDAY

SEND \$1.00 FOR DETAILED CATALOG

rush charge



7400 TTL

7400N	16	7400N	29	7400N	89
7401N	16	7401N	29	7401N	89
7402N	16	7402N	29	7402N	89
7403N	16	7403N	29	7403N	89
7404N	16	7404N	29	7404N	89
7405N	16	7405N	29	7405N	89
7406N	16	7406N	29	7406N	89
7407N	16	7407N	29	7407N	89
7408N	16	7408N	29	7408N	89
7409N	16	7409N	29	7409N	89
7410N	16	7410N	29	7410N	89
7411N	16	7411N	29	7411N	89
7412N	16	7412N	29	7412N	89
7413N	16	7413N	29	7413N	89
7414N	16	7414N	29	7414N	89
7415N	16	7415N	29	7415N	89
7416N	16	7416N	29	7416N	89
7417N	16	7417N	29	7417N	89
7418N	16	7418N	29	7418N	89
7419N	16	7419N	29	7419N	89
7420N	16	7420N	29	7420N	89
7421N	16	7421N	29	7421N	89
7422N	16	7422N	29	7422N	89
7423N	16	7423N	29	7423N	89
7424N	16	7424N	29	7424N	89
7425N	16	7425N	29	7425N	89
7426N	16	7426N	29	7426N	89
7427N	16	7427N	29	7427N	89
7428N	16	7428N	29	7428N	89
7429N	16	7429N	29	7429N	89
7430N	16	7430N	29	7430N	89
7431N	16	7431N	29	7431N	89
7432N	16	7432N	29	7432N	89
7433N	16	7433N	29	7433N	89
7434N	16	7434N	29	7434N	89
7435N	16	7435N	29	7435N	89
7436N	16	7436N	29	7436N	89
7437N	16	7437N	29	7437N	89
7438N	16	7438N	29	7438N	89
7439N	16	7439N	29	7439N	89
7440N	16	7440N	29	7440N	89

20% Discount 100 pin combined order 25% - 1000 pins 35%

Jameco New Kits

Digital Stopwatch Kit

- Use Integral 7005 Chip
- Plated thru double-sided PCB
- 100% Board
- LED display (red)
- 100% Test: 50 sec. auto. auto read
- Quartz crystal controlled
- Three stopwatch in one: single event, split (cumulative) and timer (continuous timing)
- Use 3 probe holders
- 100% Test: 15" x 10"

JE900 \$39.95

ALSO AVAILABLE:
JE200 5v lamp power supply \$14.95
JE206 Function Generator \$19.95
JE370 4-digit clock kit 14.95
JE477 Jumbo 6-digit clock kit 29.95

6-Digit Clock Kit

- Bright 30 HZ common cathode display
- Uses MM534 clock chip
- Switches for hours, minutes and hold functions
- Hours easily visible to 20 test
- 115 VAC operation
- 24 or 24 hour operation
- Includes all components, case and wall transformer
- Size: 6-3/4" x 3-1/2" x 1-3/4"

J301 \$19.95

DISCRETE LEADS

XC200R	red	5/81	120° dia.				
XC200G	green	4/81	XC200R	red	5/81		
XC200B	blue	4/81	XC200G	green	4/81		
XC200Y	yellow	4/81	XC200B	blue	4/81		
XC200C	clear	4/81	XC200Y	yellow	4/81		
200° dia.							
XC220R	red	5/81	XC200C	clear	4/81		
XC220G	green	4/81	XC220R	red	5/81		
XC220Y	yellow	4/81	XC220G	green	4/81		
170° dia.							
MV10B	red	4/81	XC220Y	yellow	4/81		
105° dia.							
MV50	red	6/81	XC220C	clear	4/81		
190° dia.							
XC111R						red	green
XC111G						red	green
XC111Y						red	green
XC111C						red	green
XC111B						red	green
XC111W						red	green
XC111P						red	green
XC111M						red	green
XC111L						red	green
XC111O						red	green
XC111V						red	green
XC111I						red	green
XC111U						red	green
XC111R						red	green
XC111G						red	green
XC111Y						red	green
XC111C						red	green
XC111B						red	green
XC111W						red	green
XC111P						red	green
XC111M						red	green
XC111L						red	green
XC111O						red	green
XC111V						red	green
XC111I						red	green
XC111U						red	green
XC111R						red	green
XC111G						red	green
XC111Y						red	green
XC111C						red	green
XC111B						red	green
XC111W						red	green
XC111P						red	green
XC111M						red	green
XC111L						red	green
XC111O						red	green
XC111V						red	green
XC111I						red	green
XC111U						red	green
XC111R						red	green
XC111G						red	green
XC111Y						red	green
XC111C						red	green
XC111B						red	green
XC111W						red	green
XC111P						red	green
XC111M						red	green
XC111L						red	green
XC111O						red	green
XC111V						red	green
XC111I						red	green
XC111U						red	green
XC111R						red	green
XC111G						red	green
XC111Y						red	green
XC111C						red	green
XC111B						red	green
XC111W						red	green
XC111P						red	green
XC111M						red	green
XC111L						red	green
XC111O						red	green
XC111V						red	green
XC111I						red	green
XC111U						red	green
XC111R						red	green
XC111G						red	green
XC111Y						red	green
XC111C						red	green
XC111B						red	green
XC111W						red	green
XC111P						red	green
XC111M						red	green
XC111L						red	green
XC111O						red	green
XC111V						red	green
XC111I						red	green
XC111U						red	green
XC111R						red	green
XC111G						red	green
XC111Y						red	green
XC111C						red	green
XC111B						red	green
XC111W						red	green
XC111P						red	green
XC111M						red	green
XC111L						red	green
XC111O						red	green
XC111V						red	green
XC111I						red	green
XC111U						red	green
XC111R						red	green
XC111G						red	green
XC111Y						red	green
XC111C						red	green
XC111B						red	green
XC111W						red	green
XC111P						red	green
XC111M						red	green
XC111L						red	green
XC111O						red	green
XC111V						red	green
XC111I						red	green
XC111U						red	green
XC111R						red	green
XC111G						red	green
XC111Y						red	green
XC111C						red	green
XC111B						red	green
XC111W						red	green
XC111P						red	green
XC111M						red	green
XC111L						red	green
XC111O						red	green
XC111V						red	green
XC111I						red	green
XC111U						red	green
XC111R						red	green
XC111G						red	green
XC111Y						red	green
XC111C						red	green
XC111B						red	green
XC111W						red	green
XC111P						red	green
XC111M						red	green
XC111L						red	green
XC111O						red	green
XC111V						red	green
XC111I						red	green
XC111U						red	green
XC111R						red	green
XC111G						red	green
XC111Y						red	green
XC111C						red	green
XC111B						red	green
XC111W						red	green
XC111P						red	green
XC111M						red	green
XC111L						red	green
XC111O						red	green
XC111V						red	green
XC111I						red	green
XC111U						red	green
XC111R						red	green
XC111G						red	green
XC111Y						red	green
XC111C						red	green
XC111B						red	green
XC111W						red	green
XC111P						red	green
XC111M						red	green
XC111L						red	green
XC111O						red	green
XC111V						red	green
XC111I						red	green
XC111U						red	green
XC111R						red	green
XC111G						red	green
XC111Y						red	green
XC111C						red	green
XC111B						red	green
XC111W						red	green
XC111P						red	green
XC111M						red	green
XC111L						red	green
XC111O						red	green
XC111V						red	green
XC111I						red	green
XC111U						red	green
XC111R						red	green
XC111G						red	green
XC111Y						red	green
XC111C						red	green
XC111B						red	green
XC111W						red	green
XC111P						red	green
XC111M						red	green
XC111L						red	green
XC111O						red	green
XC111V						red	green
XC111I						red	green
XC111U						red	green
XC111R						red	green
XC111G						red	green
XC111Y						red	green
XC111C						red	green
XC111B						red	green
XC111W						red	green
XC111P						red	green
XC111M						red	green
XC111L						red	green
XC111O						red	green
XC111V						red	green
XC111I						red	green
XC111U						red	green
XC111R						red	green
XC111G						red	green
XC111Y						red	green
XC111C						red	green
XC111B						red	green
XC111W						red	green
XC111P						red	green
XC111M						red	green
XC111L						red	green
XC111O						red	green
XC111V						red	green
XC111I						red	green
XC111U						red	green
XC111R						red	green
XC111G						red	green
XC111Y						red	green
XC111C						red	green
XC111B						red	green
XC111W						red	green
XC111P						red	green
XC111M						red	green
XC111L						red	green
XC111O						red	green
XC111V						red	green
XC111I						red	green
XC111U						red	green
XC111R						red	green
XC111G						red	green
XC111Y						red	green
XC111C						red	green
XC111B						red	green
XC111W						red	green
XC111P						red	green
XC111M						red	green
XC111L						red	green
XC111O						red	green
XC111V						red	green
XC111I						red	green
XC111U						red	green
XC111R						red	green
XC111G						red	green
XC111Y						red	green
XC111C						red	green
XC111B						red	green
XC111W						red	green
XC111P						red	green
XC111M						red	green
XC111L						red	green
XC111O						red	green
XC111V						red	green
XC111I						red	green
XC111U						red	green
XC111R						red	green
XC111G						red	green
XC111Y						red	green
XC111C						red	green
XC111B						red	green
XC111W						red	green
XC111P						red	green
XC111M						red	green
XC111L						red	green
XC111O						red	green
XC111V						red	green
XC111I						red	green
XC111U						red	green
XC111R						red	green
XC111G						red	green
XC111Y						red	green
XC111C						red	green
XC111B						red	green
XC111W						red	green
XC111P						red	green
XC111M						red	green
XC111L						red	green
XC111O						red	green
XC111V						red	green
XC111I						red	green
XC111U						red	green
XC111R						red	green
XC111G						red	green
XC111Y						red	green
XC111C						red	green
XC111B						red	green
XC111W						red	green
XC111P						red	green
XC111M						red	green
XC111L						red	green
XC111O						red	green
XC111V						red	green
XC111I						red	green
XC111U						red	green
XC111R						red	green
XC111G						red	green
XC111Y						red	green
XC111C						red	green
XC111B						red	green
XC111W						red	green
XC111P						red	green
XC111M						red	green
XC111L						red	green
XC111O						red	green
XC111V						red	green
XC111I						red	green
XC111U						red	green
XC111R						red	green
XC111G						red	green
XC111Y						red	green
XC111C						red	green
XC111B						red	green
XC111W						red	green
XC111P						red	green
XC111M						red	green
XC111L						red	green
XC111O						red	green
XC111V						red	green
XC111I						red	green
XC111U						red	green
XC111R						red	green
XC111G						red	green
XC111Y						red	green
XC111C						red	green
XC111B						red	green
XC111W						red	green
XC111P						red	green
XC111M						red	green
XC111L						red	green
XC111O						red	green
XC111V						red	green
XC111I						red	green
XC111U						red	green
XC111R						red	green
XC111G						red	green
XC111Y						red	green
XC111C						red	green
XC111B						red	green
XC111W						red	green
XC111P						red	green
XC111M						red	green
XC111L						red	green
XC111O						red	green
XC111V						red	green
XC111I						red	green
XC111U						red	green
XC111R						red	green
XC111G						red	green
XC111Y						red	green
XC111C						red	green
XC111B						red	green
XC111W						red	green
XC111P						red	green
XC111M						red	green
XC111L						red	green
XC111O						red	green
XC111V						red	green
XC111I						red	green
XC111U						red	green
XC111R						red	green
XC111G						red	green
XC111Y						red	green
XC111C						red	green
XC111B						red	green
XC111W						red	green
XC111P						red	green
XC111M						red	green
XC111L						red	green
XC111O						red	green
XC111V						red	green
XC111I						red	green
XC111U						red	green
XC111R						red	green
XC111G						red	green
XC111Y						red	green
XC111C						red	green
XC111B						red	green
XC111W						red	green
XC111P						red	green
XC111M						red	green
XC111L						red	green
XC111O						red	green
XC111V						red	green
XC111I						red	green
XC111U						red	green
XC111R						red	green
XC111G						red	green
XC111Y						red	green
XC111C						red	green
XC111B						red	green
XC111W						red	green
XC111P						red	green
XC111M						red	green
XC111L						red	green
XC111O						red	green
XC111V						red	green
XC111I						red	green
XC111U						red	green
XC111R						red	green
XC111G						red	green
XC111Y						red	green
XC111C						red	green
XC111B						red	green
XC111W						red	green
XC111P						red	green
XC111M						red	green
XC111L						red	green
XC111O						red	green
XC111V						red	green
XC111I						red	green
XC111U						red	green
XC111R						red	green
XC111G						red	green
XC111Y						red	green
XC111C						red	

LIQUID CRYSTAL DISPLAY

FIELD EFFECT

4 DIGIT - .5" CHARACTERS
THREE ENUNCIATORS
2.00" X 1.20" PACKAGE
INCLUDES CONNECTOR

T1001-Transmissive \$7.95

T1001A-Reflective 8.25

LEDs

DISPLAY LEADS

MAN 3	5 x 7 D Matrix-red	300	4.95
MAN 2	Common Cathode-red	125	25
MAN 1	Common Cathode-yellow	187	34.95
MAN 76	Common Anode-yellow	300	1.25
MAN 77	Common Anode-yellow	160	90
MAN 78	Common Cathode-yellow	300	1.25
MAN 74	Common Cathode-red	300	1.25
MAN 82	Common Anode-yellow	300	90
MAN 83	Common Cathode-yellow	300	90
MAN 3020	Common Anode-orange	300	90
MAN 3630	Common Anode-orange	300	90
MAN 3630	Common Cathode-orange	300	90
MAN 4010	Common Cathode-orange	300	90
MAN 4010	Common Cathode-orange	300	90
MAN 4040	Common Cathode-orange	430	90
MAN 4710	Common Anode-red	400	90
MAN 4720	Common Cathode-red	400	90
MAN 4740	Common Cathode-red	400	90
MAN 4740	Common Cathode-red	400	90
MAN 4810	Common Anode-yellow	430	90
MAN 4810	Common Cathode-yellow	430	90
MAN 5010	Common Cathode-orange	560	90
MAN 5010	Common Cathode-orange	560	90
MAN 5050	Common Cathode-orange	560	90
MAN 5050	Common Cathode-orange	560	90

DIODES

MAN 5740	Common Cathode-red	585	390
MAN 5750	Common Cathode-red	585	390
MAN 5760	Common Cathode-red	585	390
MAN 5770	Common Cathode-red	585	390
MAN 5780	Common Cathode-red	585	390
MAN 131	Common Anode-red ± 1	300	106
MAN 132	Common Anode-red ± 1	300	106
MAN 133	Common Anode-red ± 1	300	106
MAN 134	Common Anode-red ± 1	300	106
MAN 135	Common Cathode-red	585	390
MAN 136	Common Cathode-red	585	390
MAN 137	Common Cathode-red	585	390
MAN 138	Common Cathode-red	585	390
MAN 139	Common Cathode-red	585	390
MAN 140	Common Cathode-red	585	390
MAN 141	Common Cathode-red	585	390
MAN 142	Common Cathode-red	585	390
MAN 143	Common Cathode-red	585	390
MAN 144	Common Cathode-red	585	390
MAN 145	Common Cathode-red	585	390
MAN 146	Common Cathode-red	585	390
MAN 147	Common Cathode-red	585	390
MAN 148	Common Cathode-red	585	390
MAN 149	Common Cathode-red	585	390
MAN 150	Common Cathode-red	585	390
MAN 151	Common Cathode-red	585	390
MAN 152	Common Cathode-red	585	390
MAN 153	Common Cathode-red	585	390
MAN 154	Common Cathode-red	585	390
MAN 155	Common Cathode-red	585	390
MAN 156	Common Cathode-red	585	390
MAN 157	Common Cathode-red	585	390
MAN 158	Common Cathode-red	585	390
MAN 159	Common Cathode-red	585	390
MAN 160	Common Cathode-red	585	390
MAN 161	Common Cathode-red	585	390
MAN 162	Common Cathode-red	585	390
MAN 163	Common Cathode-red	585	390
MAN 164	Common Cathode-red	585	390
MAN 165	Common Cathode-red	585	390
MAN 166	Common Cathode-red	585	390
MAN 167	Common Cathode-red	585	390
MAN 168	Common Cathode-red	585	390
MAN 169	Common Cathode-red	585	390
MAN 170	Common Cathode-red	585	390
MAN 171	Common Cathode-red	585	390
MAN 172	Common Cathode-red	585	390
MAN 173	Common Cathode-red	585	390
MAN 174	Common Cathode-red	585	390
MAN 175	Common Cathode-red	585	390
MAN 176	Common Cathode-red	585	390
MAN 177	Common Cathode-red	585	390
MAN 178	Common Cathode-red	585	390
MAN 179	Common Cathode-red	585	390
MAN 180	Common Cathode-red	585	390
MAN 181	Common Cathode-red	585	390
MAN 182	Common Cathode-red	585	390
MAN 183	Common Cathode-red	585	390
MAN 184	Common Cathode-red	585	390
MAN 185	Common Cathode-red	585	390
MAN 186	Common Cathode-red	585	390
MAN 187	Common Cathode-red	585	390
MAN 188	Common Cathode-red	585	390
MAN 189	Common Cathode-red	585	390
MAN 190	Common Cathode-red	585	390
MAN 191	Common Cathode-red	585	390
MAN 192	Common Cathode-red	585	390
MAN 193	Common Cathode-red	585	390
MAN 194	Common Cathode-red	585	390
MAN 195	Common Cathode-red	585	390
MAN 196	Common Cathode-red	585	390
MAN 197	Common Cathode-red	585	390
MAN 198	Common Cathode-red	585	390
MAN 199	Common Cathode-red	585	390
MAN 200	Common Cathode-red	585	390
MAN 201	Common Cathode-red	585	390
MAN 202	Common Cathode-red	585	390
MAN 203	Common Cathode-red	585	390
MAN 204	Common Cathode-red	585	390
MAN 205	Common Cathode-red	585	390
MAN 206	Common Cathode-red	585	390
MAN 207	Common Cathode-red	585	390
MAN 208	Common Cathode-red	585	390
MAN 209	Common Cathode-red	585	390
MAN 210	Common Cathode-red	585	390
MAN 211	Common Cathode-red	585	390
MAN 212	Common Cathode-red	585	390
MAN 213	Common Cathode-red	585	390
MAN 214	Common Cathode-red	585	390
MAN 215	Common Cathode-red	585	390
MAN 216	Common Cathode-red	585	390
MAN 217	Common Cathode-red	585	390
MAN 218	Common Cathode-red	585	390
MAN 219	Common Cathode-red	585	390
MAN 220	Common Cathode-red	585	390
MAN 221	Common Cathode-red	585	390
MAN 222	Common Cathode-red	585	390
MAN 223	Common Cathode-red	585	390
MAN 224	Common Cathode-red	585	390
MAN 225	Common Cathode-red	585	390
MAN 226	Common Cathode-red	585	390
MAN 227	Common Cathode-red	585	390
MAN 228	Common Cathode-red	585	390
MAN 229	Common Cathode-red	585	390
MAN 230	Common Cathode-red	585	390
MAN 231	Common Cathode-red	585	390
MAN 232	Common Cathode-red	585	390
MAN 233	Common Cathode-red	585	390
MAN 234	Common Cathode-red	585	390
MAN 235	Common Cathode-red	585	390
MAN 236	Common Cathode-red	585	390
MAN 237	Common Cathode-red	585	390
MAN 238	Common Cathode-red	585	390
MAN 239	Common Cathode-red	585	390
MAN 240	Common Cathode-red	585	390
MAN 241	Common Cathode-red	585	390
MAN 242	Common Cathode-red	585	390
MAN 243	Common Cathode-red	585	390
MAN 244	Common Cathode-red	585	390
MAN 245	Common Cathode-red	585	390
MAN 246	Common Cathode-red	585	390
MAN 247	Common Cathode-red	585	390
MAN 248	Common Cathode-red	585	390
MAN 249	Common Cathode-red	585	390
MAN 250	Common Cathode-red	585	390
MAN 251	Common Cathode-red	585	390
MAN 252	Common Cathode-red	585	390
MAN 253	Common Cathode-red	585	390
MAN 254	Common Cathode-red	585	390
MAN 255	Common Cathode-red	585	390
MAN 256	Common Cathode-red	585	390
MAN 257	Common Cathode-red	585	390
MAN 258	Common Cathode-red	585	390
MAN 259	Common Cathode-red	585	390
MAN 260	Common Cathode-red	585	390
MAN 261	Common Cathode-red	585	390
MAN 262	Common Cathode-red	585	390
MAN 263	Common Cathode-red	585	390
MAN 264	Common Cathode-red	585	390
MAN 265	Common Cathode-red	585	390
MAN 266	Common Cathode-red	585	390
MAN 267	Common Cathode-red	585	390
MAN 268	Common Cathode-red	585	390
MAN 269	Common Cathode-red	585	390
MAN 270	Common Cathode-red	585	390
MAN 271	Common Cathode-red	585	390
MAN 272	Common Cathode-red	585	390
MAN 273	Common Cathode-red	585	390
MAN 274	Common Cathode-red	585	390
MAN 275	Common Cathode-red	585	390
MAN 276	Common Cathode-red	585	390
MAN 277	Common Cathode-red	585	390
MAN 278	Common Cathode-red	585	390
MAN 279	Common Cathode-red	585	390
MAN 280	Common Cathode-red	585	390
MAN 281	Common Cathode-red	585	390
MAN 282	Common Cathode-red	585	390
MAN 283	Common Cathode-red	585	390
MAN 284	Common Cathode-red	585	390
MAN 285	Common Cathode-red	585	390
MAN 286	Common Cathode-red	585	390
MAN 287	Common Cathode-red	585	390
MAN 288	Common Cathode-red	585	390
MAN 289	Common Cathode-red	585	390
MAN 290	Common Cathode-red	585	390
MAN 291	Common Cathode-red	585	390
MAN 292	Common Cathode-red	585	390
MAN 293	Common Cathode-red	585	390
MAN 294	Common Cathode-red	585	390
MAN 295	Common Cathode-red	585	390
MAN 296	Common Cathode-red	585	390
MAN 297	Common Cathode-red	585	390
MAN 298	Common Cathode-red	585	390
MAN 299	Common Cathode-red	585	390
MAN 300	Common Cathode-red	585	390
MAN 301	Common Cathode-red	585	390
MAN 302	Common Cathode-red	585	390
MAN 303	Common Cathode-red	585	390
MAN 304	Common Cathode-red	585	390
MAN 305	Common Cathode-red	585	390
MAN 306	Common Cathode-red	585	390
MAN 307	Common Cathode-red	585	390
MAN 308	Common Cathode-red	585	390
MAN 309	Common Cathode-red	585	390
MAN 310	Common Cathode-red	585	390
MAN 311	Common Cathode-red	585	390
MAN 312	Common Cathode-red	585	390
MAN 313	Common Cathode-red	585	390
MAN 314	Common Cathode-red	585	390
MAN 315	Common Cathode-red	585	390
MAN 316	Common Cathode-red	585	390
MAN 317	Common Cathode-red	585	390
MAN 318	Common Cathode-red	585	390
MAN 319	Common Cathode-red	585	390
MAN 320	Common Cathode-red	585	390
MAN 321	Common Cathode-red	585	390
MAN 322	Common Cathode-red	585	390
MAN 323	Common Cathode-red	585	390
MAN 324	Common Cathode-red	585	390
MAN 325	Common Cathode-red	585	390
MAN 326	Common Cathode-red	585	390
MAN 327	Common Cathode-red	585	390
MAN 328	Common Cathode-red	585	390
MAN 329	Common Cathode-red	585	390
MAN 330	Common Cathode-red	585	390
MAN 331	Common Cathode-red	585	390
MAN 332	Common Cathode-red	585	390
MAN 333	Common Cathode-red	585	390
MAN 334	Common Cathode-red	585	390
MAN 335	Common Cathode-red	585	390
MAN 336	Common Cathode-red	585	390
MAN 337	Common Cathode-red	585	390
MAN 338	Common Cathode-red	585	390
MAN 339	Common Cathode-red	585	390
MAN 340	Common Cathode-red	585	390
MAN 341	Common Cathode-red	585	390
MAN 342	Common Cathode-red	585	390
MAN 343	Common Cathode-red	585	390
MAN 344	Common Cathode-red	585	390
MAN 345	Common Cathode-red	585	390
MAN 346	Common Cathode-red	585	390
MAN 347	Common Cathode-red	585	390
MAN 348	Common Cathode-red	585	390
MAN 349	Common Cathode-red	585	390
MAN 350	Common Cathode-red	585	390
MAN 351	Common Cathode-red	585	390
MAN 352	Common Cathode-red	585	390
MAN 353	Common Cathode-red	585	390
MAN 354	Common Cathode-red	585	390
MAN 355	Common Cathode-red	585	390
MAN 356	Common Cathode-red	585	390
MAN 357	Common Cathode-red	585	390
MAN 358	Common Cathode-red	585	390
MAN 359	Common Cathode-red	585	390
MAN 360	Common Cathode-red	585	390
MAN 361	Common Cathode-red	585	390
MAN 362	Common Cathode-red	585	390
MAN 363	Common Cathode-red	585	390
MAN 364	Common Cathode-red	585	390
MAN 365	Common Cathode-red	585	390
MAN 366	Common Cathode-red	585	390
MAN 367	Common Cathode-red	585	390
MAN 368	Common Cathode-red	585	390
MAN 369	Common Cathode-red	585	390
MAN 370	Common Cathode-red	585	390
MAN 371	Common Cathode-red	585	390
MAN 372	Common Cathode-red	585	390
MAN 373	Common Cathode-red	585	390
MAN 374	Common Cathode-red	585	390
MAN 375	Common Cathode-red	585	390
MAN 376	Common Cathode-red	585	390
MAN 377	Common Cathode-red	585	390
MAN 378	Common Cathode-red	585	390
MAN 379	Common Cathode-red	585	390
MAN 380	Common Cathode-red	585	390
MAN 381	Common Cathode-red	585	390
MAN 382	Common Cathode-red	585	390
MAN 383	Common Cathode-red	585	390
MAN 384	Common Cathode-red	585	390
MAN 385	Common Cathode-red	585	390
MAN 386	Common Cathode-red	585	390
MAN 387	Common Cathode-red	585	390
MAN 388	Common Cathode-red	585	390
MAN 389	Common Cathode-red	585	390
MAN 390	Common Cathode-red	585	390
MAN 391	Common Cathode-red	585	390
MAN 392	Common Cathode-red	585	390
MAN 393	Common Cathode-red	585	390
MAN 394	Common Cathode-red	585	390
MAN 395	Common Cathode-red	585	390
MAN 396	Common Cathode-red	585	390
MAN 397	Common Cathode-red	585	390
MAN 398	Common Cathode-red	585	390
MAN 399	Common Cathode-red	585	390
MAN 400	Common Cathode-red	585	390
MAN 401	Common Cathode-red	585	390
MAN 402	Common Cathode-red	585	390
MAN 403	Common Cathode-red	585	390
MAN 404	Common Cathode-red	585	390
MAN 405	Common Cathode-red	585	390
MAN 406	Common Cathode-red	585	390
MAN 407	Common Cathode-red	585	390
MAN 408	Common Cathode-red	585	390
MAN 409	Common Cathode-red	585	390
MAN 410	Common Cathode-red	585	390
MAN 411	Common Cathode-red	585	390
MAN 412	Common Cathode-red	585	390
MAN 413	Common Cathode-red	585	390
MAN 414	Common Cathode-red	585	390
MAN 415	Common Cathode-red	585	390
MAN 416	Common Cathode-red	585	390
MAN 417	Common Cathode-red	585	390
MAN 418	Common Cathode-red	585	390
MAN 419	Common Cathode-red	585	390
MAN 420	Common Cathode-red	585	390
MAN 421	Common Cathode-red	585	390
MAN 422	Common Cathode-red	585	390
MAN 423	Common Cathode-red	585	390
MAN 424	Common Cathode-red	585	390
MAN 425	Common Cathode-red	585	390
MAN 426	Common Cathode-red	585	390
MAN 427	Common Cathode-red	585	390
MAN 428	Common Cathode-red	585	390
MAN 429	Common Cathode-red	585	390
MAN 430	Common Cathode-red	585	390
MAN 431	Common Cathode-red	585	390
MAN 432	Common Cathode-red	585	390
MAN 433	Common Cathode-red	585	390
MAN 434	Common Cathode-red	585	390
MAN 435	Common Cathode-red	585	390
MAN 436	Common Cathode-red	585	390
MAN 437	Common Cathode-red	585	390
MAN 438	Common Cathode-red	585	390
MAN 439	Common Cathode-red	585	390
MAN 440	Common Cathode-red	585	390
MAN 441	Common Cathode-red	585	390
MAN 442	Common Cathode-red		

TYPE POLARITY

RCA LINEAR			CALCULATOR CHIPS/DRIVERS	
CA3012T	2.15	CA3062N	2.00	
CA3023T	2.56	CA3063N	1.80	MM5725
CA3025T	2.46	CA3065N	.85	MM5738
CA3026T	1.35	CA3066N	3.75	DM864
CA3046N	1.30	CA3126T		39M865
CA3059N	3.25	CA3140T	1.25	DM897
CA3060N	3.35	CA3165T	1.35	CA3 LED
CA3063T	2.05	CA3070N	.48	927A 2.7 sec
CA3081N	2.00	CA3080N	3.50	C.A. LED driver

TYPE POLARITY

CLOCK CHIPS		MOTOROLA	
MM5339	\$4.95	MC1486L	\$4.95
MM5311	4.95	MC1486L	5.75
MM5312	4.95	MC1493L	2.95
MM5314	4.95	MC3202P	2.95
MM5316	6.95	MC3206P	2.95
MM5318	9.95	MC0415(74416)	7.50
MM5369	2.95	MC4824P	3.95
MM5387/7998A	4.95	MC4840P	6.95
MM5341	9.95	MC4844P	4.50
CPU FILE (TIN) SOCKETS			

TYPE POLARITY

16 pin LP	29	28	27	SOLD TAIL ST
20 pin LP	34	32	30	
14 pin ST	\$.27	26	24	
16 pin ST	30	27	25	SOLD TAIL ST
18 pin ST	35	32	30	
24 pin ST	49	45	42	
8 pin SG	\$.30	27	24	SOLD TAIL ST
14 pin SG	35	32	29	
16 pin SG	38	36	32	
18 pin SG	52	47	43	WIRE WRAP
20 pin SG	55	50	46	
24 pin SG	69	64	59	

FREQUENCY COUNTER KIT

Outstanding Performance

Incredible Price **\$89.95**

CT-50 FREQUENCY COUNTER

65140329

ramsay electronics



The CT-50 is a versatile and precision frequency counter which will measure frequencies to 60 MHz and up to 600 MHz with the CT-600 option. Large Scale Integration, CMOS circuitry and solid state display technology have enabled this counter to match performance found in units selling for over three times as much. Low power consumption (typically 300-400 ma) makes the CT-50 ideal for portable battery operation. Features of the CT-50 include: large 8 digit LED display, RF shielded all metal case, easy pushbutton operation, automatic decimal point, fully socketed IC chips and input protection to 50 volts to insure against accidental burnout or overload. And, the best feature of all is the easy assembly. Clear, step by step instructions guide you to a finished unit you can rely on. Order your today!

CT-50 60 MHz counter kit **\$89.95**
CT-50WT 60 MHz counter, wired and tested **\$99.95**
CT-600 600 MHz scaler option, add **29.95**

CB-1 Color TV calibrator-stabilizer **\$149.95**
DP-1 DC probe, general purpose probe **12.95**
HP-1 High impedance probe, non-load **15.95**

SPECIFICATIONS:

Frequency range: 0 Hz to 65 MHz, 600 MHz with CT-600
Resolution: 10 Hz, 0.1 sec gate, 1 Hz, 0.1 sec gate
Readout: 8 digit, 0.4" high LED, direct readout in mHz
Accuracy: adjustable to 0.5 ppm
Stability: 2.5 ppm over 10 to 40°C temperature, compensated
Input: BNC, 1 megohm, 20 pF direct 50 ohm with CT-600
Overload: 50VAC maximum, all modes
Sensitivity: less than 25 mV to 65 mHz, 50-150 mV to 600 mHz
Power: 110 VAC, 5 Watts or 12 VDC @ 400 ma
Size: 6" x 4" x 2", high quality aluminum case, 2 lbs
ICS: 13 units, all socketed

OP-AMP SPECIAL

741 mini dip **12/\$2.00**
BI-FET, mini dip, 741 type **10/\$2.00**

VIDEO TERMINAL

A completely self-contained, stand alone video terminal card. Requires only an ASCII keyboard and TV set to become a complete terminal unit. Two units available, common features are: single 5V supply, XTAL controlled sync and baud rates (to 9600), complete computer and keyboard control of cursor. Parity error control and display. Accepts and generates serial ASCII plus parallel keyboard input. The 3216 is 32 char. by 16 lines, 2 pages with memory dump feature. The 6416 is 64 char. by 16 lines, with scrolling, upper and lower case (optional) and has RS-232 and 20ma loop interfaces on board. Kits include sockets and complete documentation.
RE 3216, terminal card **\$149.95**
RE 6416, terminal card **189.95**
Lower Case option, 6416 only **13.95**
Power Supply Kit **14.95**
Video/RF Modulator, VD-1 **6.95**
Assembled, tested units, add **60.00**

CALENDAR ALARM CLOCK

The clock that's got it all: 6-5" LEDs, 12/24 hour, snooze, 24 hour alarm, 4 year calendar, battery backed, and lots more. The super 7001 chip is used. Size: 5x4x2 inches.
Complete kit, less case (not available) **\$34.95**
DC-9

30 Watt 2 mtr PWR AMP

Simple Class C power amp features 8 times power gain. 1 W in for 8 out, 2 in for 15 out, 4 W in for 30 out. Max. output of 35 W, incredible value, complete with all parts, less case and T-R relay.
PA-1, 30 W pwr amp kit **\$22.95**
TR-1, RF sensed T-R relay kit **6.95**

SUPER SLEUTH

A super sensitive amplifier which will pick up a pin drop at 15 feet! Great for monitoring baby's room or as general purpose amplifier. Full 2 W rms output, runs on 6 to 15 volts, uses 845-ohm speaker.
Complete kit, BN-9 **\$5.95**

POWER SUPPLY KIT

Complete triple regulated power supply provides variable -6 to +18 volts at 200 ma and +5 v at 1 A. Amp. Excellent load regulation, good filtering and small size. Transistors, requires 6.3V @ 1 A and 24 VCT.
Complete kit, PS-3LT **\$6.95**

SIREN KIT

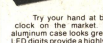
Produces upward and downward wail characteristic of a police siren. 5 W peak audio output, runs on 3-15 volts, uses 3-45 ohm speaker.
Complete kit, SM-3 **\$2.95**

FM MINI MIKE KIT

A super high performance FM wireless mike kit. Transmits a stable signal up to 300 yards with exceptional audio quality by means of its built in electret mike. Kit includes case, mike, on-off switch, antenna, battery and super instructions. This is the finest unit available.
FM-3 kit **\$12.95**
FM-3 wired and tested **16.95**

CLOCK KITS

our Best Seller
your Best Deal



Try your hand at building the finest looking clock on the market. Its satin finish anodized aluminum case looks great anywhere, while six 4" LED digits provide a highly readable display. This is a complete kit, no extras needed, and it only takes 1-2 hours to assemble. Your choice of case colors: silver, gold, bronze, black, blue (specify).
Clock kit, 12/24 hour, DC-5 **\$22.95**
Clock with 10 min. hour timer, 12/24 hour, DC-10 **27.95**
Alarm clock, 12 hour only, DC-8 **24.95**
12V DC car clock, DC-7 **27.95**
For wired and tested clocks add \$10.00 to kit price.

CAR CLOCK

The UN-KIT, only 5 solder connections

Here's a super looking, rugged and accurate auto clock which is a snap to build and install. Clock movement is completely assembled—only your solder 3 wires and 2 switches, takes about 15 minutes! Display is bright green with automatic brightness control photo cell—assures you of a highly readable display, day or night. Comes in a satin finish anodized aluminum case which can be attached 5 different ways using 2 sided tape. Choice of silver, black or gold case (specify).
DC-3 kit, 12 hour format **\$22.95**
DC-3 wired and tested **\$25.95**
110V AC adapter **\$5.95**

Under dash car clock

12/24 hour clock in a beautiful plastic case features: 6 jumbo LEDS, high accuracy (1 min. mo.), easy 3 wire hookup, display blanks with light, super instructions. Optional dimmer automatically adjusts display to ambient light level.
DC-11 clock with mini bracket **\$27.95**
DM-1 dimmer adapter **2.50**

PRESCALER

Extend the range of your counter to 600 MHz. Works with any counter. Includes 2 transistor pre-amp to give super specs, typically 20 mV at 150 MHz. Specify +10 or +100 ratio.
PS-1B, 600 MHz prescaler **\$59.95**
PS-1BK, 600 MHz prescaler kit **49.95**

FM WIRELESS MIKE KIT

Transmits up to 300' to any FM broadcast radio, uses any type of mike. Runs on 3 to 9V. FM-2 has type C semiconductor preamp stage.
FM-1 kit \$2.95 FM-2 kit \$4.95

COLOR ORGAN/MUSIC LIGHTS

Use music come alive! 3 different lights flicker with music. One light for lows, one for the mid-range and one for the highs. Each channel individually adjustable, and drives up to 300W. Great for parties, band music, mile clubs and more.
Complete kit, ML-1 **\$7.95**

LED BLINKY KIT

A great attention getter which alternately flashes 2 jumbo LEDs. Use for name badges, buttons, warning panel lights, anything! Runs on 3 to 15 volts.
Complete kit, BL-1 **\$2.95**

VIDEO MODULATOR KIT

Converts any TV to video monitor. Super stable, tunable over ch 4-5. Runs on 5-15V, accepts std video signal. Best unit on the market.
Complete kit, VD-1 **\$6.95**

TONE DECODER

A complete tone decoder on a single PC board. Features: 400-5000 Hz adjustable range via 20 turn pot, voltage regulation, 567 IC. Useful for touch-tone decoding, tone burst detection, FSK, etc. Can also be used as a stable tone encoder. Runs on 5 to 12 volts.
Complete kit, TD-1 **\$5.95**

WHISPER LIGHT KIT

An interesting kit, small mike picks up sounds and converts them to light. The louder the sound the brighter the light. Completely self-contained, includes mike, runs on 110VAC, controls up to 300 watts.
Complete kit, WL-1 **\$6.95**

Ramsey's famous MINI-KITS

ramsay electronics

BOX 4072, ROCHESTER, N.Y. 14610

PHONE ORDERS CALL

(716) 271-6487



TERMS: Satisfaction guaranteed or money refunded. COD add \$1.50. Minimum order \$6.00. Orders under \$10.00, add \$7.50. Add 5% for postage, insurance, handling. Overseas, add 15% NY residents, add 7% tax.

**SURPLUS
SPECTACULAR!**

2 METER MOBILE ANTENNA

\$12.95

Plus \$1 Shipping

FEATURES: - HIGHEST QUALITY, DESIGNED FOR USE WITH STATE C-CLASS VEHICLES, MOLDED FIBERGLASS HELICALLY WOUND HORN (FLOURESCENT ORANGE), HEAVILY PLATED PARTS, SEALED WELDING TRANSFORMER, -SINGLE HORN (1/2" DIA) WITH ALL MOUNTING HARDWARE INCLUDING TRIM RINGS AND RUBBER SEALS, ALSO WORKS WITH MOST "CLAMP TYPE" ADAPTERS, -TUNES FROM 140-176 MHz -- WHIP CUTTING CHART SHOWS WHIP LENGTH VS FREQUENCY, CUT FOR 2M HAM BAND, FIRE & POLICE BANDS (FOR SCANNERS) OR EVEN USE IN THE MARINE BAND!

-COMPLETE WITH ALL PARTS -- WHIP, LOADING COIL (TRANSFORMER), HARDWARE, COIL (RECEIVER), PL259 CONNECTOR, AND COMPLETE INSTALLATION AND TUNING INSTRUCTIONS.

DOES IT GET OUT? YOU BET IT! 1/2 WAVE VERTICALS ARE MOST WIDELY USED IN COMMERCIAL AND 2 METER FM WORK BECAUSE OF THE LOW RADIATION ANGLE AND CONCENTRATED ENERGY. ON SHORTER VERTICAL WHIPS, BANDWIDTH IS GOOD, RESULTING IN LOWER SWR OVER A WIDER FREQUENCY RANGE. A LESSER DEPENDENCY ON A GOOD PLANE MEANS EASIER MOUNTING IN MANY CASES. (THESE ANTENNAS WERE USED ON POLICE MOTORCYCLES WITH EXCELLENT RESULTS -- GROUND PLANE?) GIVE THEM A GOOD GOOD PLANE (LIKE A CAR ROOF) AND THEY'RE NEARLY UNEATABLE!



LIMITED
QUANTITIES

WHIP LENGTH (in) vs FREQ (MHz)



LASER POWER SUPPLIES

COMMERCIAL QUALITY SUPPLIES
FEATURE 120 VAC INPUT, RECTIFIED AND FILTERED DC OUTPUT! THESE NEW SUPPLIES ARE ESPECIALLY COST THE MFR ABOUT \$30 EACH IN BIG QUANTITIES, 150% FOR LASERS, BUG ZAPPERS, HIGH VOLTAGE EXPERIMENTS OF ALL SORTS. SUPPLIES ARE POTTED IN PLASTIC WITH THE RECTIFIERS ACCESSIBLE THROUGH A REMOVABLE PLATE.

**12.500 Vdc
25 Watts L-1250**
\$795 Plus \$2 Shipping
(They are HEAVY!)

**7.500 Vdc
15 Watts L-750**
\$695 Plus \$1.40 shipping

CRYSTALS

HC-6 case
tune w/ RANGER
FRESH STOCK!
D-3125
3.579 MHz \$125
4.000 MHz \$150
4.194 MHz \$150

BEZELS

NEW EAST TUNING
RINGS
RANGE VIEW, AREA RANGE
1" x 1/2" x 1/2" (1/2")
J-1200 2" Wide \$1.70
J-1300 3" Wide \$2.29
J-1400 4" Wide \$2.98

DIAMONDBACK ELECTRONICS COMPANY

PO BOX 184
SPRING VALLEY, IL 61362

FREE CATALOG
ALL MEASUREMENTS GUARANTEED
MINIMUM ORDER \$5
IL RESIDENTS ADD \$5 SALES TAX
PLEASE INCLUDE BUYER'S PORTAGE
RATES QUOTED ARE COMBINAL ON ONLY
PHONE ORDERS \$15/\$64 - \$151

FREE CATALOG
CIRCLE 70 ON FREE INFORMATION CARD

**YOUR SCOPE OR COUNTER/
TIMER CAN INSTANTLY MAKE
PRECISE CAPACITANCE MEAS-
UREMENTS WITH THE.....**

The C-PROBE is a precision test instrument using the latest CMOS IC technology to transform a capacitor's value into something your scope or counter/timer already understands -- DIGITAL PULSES. The C-PROBE replaces the usual probe and causes a direct readout of a capacitor's value from 1 pF to over 10,000 MFD on the scope or C/T.



LEVEL TERMINAL + BNC OUTPUT
3" SPACED
TEST STRIP
FOR C/T
INPUT
RANGES
1.0-1000pF
101-1000MHz
Resolution: 10pF & 100MHz

ACTUAL CAPACITANCE & SCOPE DISPLAYS MFR PROBE

TEN TURN TRIMMERS
ASSURE EXACT
PF & MFD SETTINGS AND
ZERO CONTROL FOR
STRAY CAPACITANCE

10MHz or BETTER GT 1MHz or BETTER SCOPE

SHIPPED WITHIN 10 DAYS OF ORDER FULLY CALIBRATED & WITH 100 HOUR, EASILY REPLACEABLE BATTERY

Box 3751
Thousand Oaks, CA 91320
805/495-7873

INTERNATIONAL INSTRUMENTATION, INC.
(phone operation welcome)

C-PROBES \$69.95 Each
CALIBRATION CAPACITORS
10PF RANGE \$14.95
100PF RANGE \$14.95
SHIPPING & HANDLING
USA \$2.00 EUROPE \$4.50
C&S SALES TAX

CIRCLE 24 ON FREE INFORMATION CARD

Original Japanese Replacement Parts for TV, Stereo and CB

25U10 1024 1.0	25U10 1024 1.0	25U10 1024 1.0	25U10 1024 1.0	25U10 1024 1.0	25U10 1024 1.0
25A34 30 39	25C640 .45 .50 .55	25C1114 3.60 3.60 3.80	25C3072 3.55 3.75 3.95	25A477 2.0 2.60 2.90	TA7098P 1.95 2.15 2.45
25A45 95 90 .50 .55	25C682 1.25 1.35 1.45	25C1166 3.20 3.45 3.80	25C3078 .45 .50 .55	AN2474 1.50 1.70 1.90	TA7092 4.00 4.50 4.80
25A46 1.85 2.05 2.25	25C481 1.25 1.35 1.45	25C1122 2.10 2.45 2.85	25C3091 .85 1.05 1.15	AN2475 1.50 1.70 1.90	TA7100P 1.45 1.65 1.85
25A47 30 35	25C484 1.25 1.35 1.45	25C1127 .80 .85 .95	25C3092 1.75 1.95 2.20	AN2510 1.75 1.95 2.20	TA7101P 1.55 1.75 1.95
25A48 90 1.10 1.25	25C490 .45 .50 .55	25C1162 .70 .75 .85	25C3098 3.00 3.20 3.45	BA5114 1.70 1.95 2.15	TA7103P 5.70 5.90 6.10
25A49 30 40	25C509 .30 .40 .45	25C1166 .25 .30 .35	25D72 5.00 .60 .65	BA521 1.85 2.05 2.25	TA7120P 2.55 2.60 2.85
25A50 30 35	25C517 2.90 3.10 3.25	25C1178 3.10 3.50 3.85	25D91 1.30 1.40 1.55	HA1511 1.45 1.70 1.85	TA7094P 1.95 2.10 2.45
25A51 30 40	25C526 .30 .35 .40	25C1177 10.10 12.40 13.80	25D92 1.40 1.55 1.75	HA1568 1.90 2.10 2.40	TA7126P 1.55 1.75 1.95
25A52 30 40	25C530 .45 .50 .55	25C1200 .25 .35 .40	25D180 1.55 1.75 1.95	HA1568P 1.90 2.10 2.40	TA7210P 4.20 4.50 4.80
25A53 30 40	25C532A .35 .40 .45	25C1220 .30 .35 .40	25D187 .30 .40 .45	HA1569 2.00 2.20 2.40	TA7211P 1.25 1.40 1.55
25A54 30 40	25C534A .45 .50 .55	25C1228A .50 .60 .70	25D234 .80 .90 .95	HA1569P 2.05 2.25 2.45	TA7160P 5.80 6.00 6.20
25A55 30 40	25C578A 3.20 3.50 3.90	25C1237 1.70 1.90 2.15	25D235 .60 .70 .80	HA1570 2.10 2.30 2.50	TA7165P 4.40 4.60 4.80
25A56 30 40	25C710 .20 .27 .30	25C1262 2.15 2.45 2.85	25D236 .60 .70 .80	HA1571 1.75 1.95 2.20	TA7166P 1.85 2.05 2.25
25A57 30 40	25C711 .20 .27 .30	25C1306 1.25 1.65 1.85	25D237 2.50 2.65 2.85	HA1572 1.75 1.95 2.20	TA7167P 1.55 1.75 1.95
25A58 30 40	25C712 .20 .27 .30	25C1307 2.15 2.45 2.85	25D238 2.05 2.45 2.75	HA1573 1.75 1.95 2.20	TA7168P 1.55 1.75 1.95
25A59 30 40	25C713 .20 .27 .30	25C1318 .30 .35 .40	25D313 .60 .70 .80	HA1574 1.75 1.95 2.20	TA7169P 1.55 1.75 1.95
25A60 95 90 .50 .55	25C713A 2.95 3.15 3.35	25C1364 .30 .35 .40	25D315 .60 .70 .80	HA1575 1.75 1.95 2.20	TA7170P 1.55 1.75 1.95
25A61 30 40	25C714 .20 .27 .30	25C1383 .30 .35 .40	25D325 .60 .70 .80	HA1576 1.75 1.95 2.20	TA7171P 1.55 1.75 1.95
25A62 30 40	25C715 .20 .27 .30	25C1424 2.75 2.85 2.95	25D326 .60 .70 .80	HA1577 1.75 1.95 2.20	TA7172P 1.55 1.75 1.95
25A63 15 4.0 4.5	25C716 .20 .27 .30	25C1448A 1.00 1.10 1.20	25D327 .60 .70 .80	HA1578 1.75 1.95 2.20	TA7173P 1.55 1.75 1.95
25A64 30 40	25C717 .20 .27 .30	25C1509 .55 .65 .75	25D328 .60 .70 .80	HA1579 1.75 1.95 2.20	TA7174P 1.55 1.75 1.95
25A65 30 40	25C718 .20 .27 .30	25C1567A .55 .65 .75	25D329 .60 .70 .80	HA1580 1.75 1.95 2.20	TA7175P 1.55 1.75 1.95
25A66 30 40	25C719 .20 .27 .30	25C1675 .25 .30 .35	25D330 .60 .70 .80	HA1581 1.75 1.95 2.20	TA7176P 1.55 1.75 1.95
25A67 30 40	25C720 .20 .27 .30	25C1676 .25 .30 .35	25D331 .60 .70 .80	HA1582 1.75 1.95 2.20	TA7177P 1.55 1.75 1.95
25A68 30 40	25C721 .20 .27 .30	25C1677 .25 .30 .35	25D332 .60 .70 .80	HA1583 1.75 1.95 2.20	TA7178P 1.55 1.75 1.95
25A69 30 40	25C722 .20 .27 .30	25C1678 .25 .30 .35	25D333 .60 .70 .80	HA1584 1.75 1.95 2.20	TA7179P 1.55 1.75 1.95
25A70 30 40	25C723 .20 .27 .30	25C1679 .25 .30 .35	25D334 .60 .70 .80	HA1585 1.75 1.95 2.20	TA7180P 1.55 1.75 1.95
25A71 30 40	25C724 .20 .27 .30	25C1680 .25 .30 .35	25D335 .60 .70 .80	HA1586 1.75 1.95 2.20	TA7181P 1.55 1.75 1.95
25A72 30 40	25C725 .20 .27 .30	25C1681 .25 .30 .35	25D336 .60 .70 .80	HA1587 1.75 1.95 2.20	TA7182P 1.55 1.75 1.95
25A73 30 40	25C726 .20 .27 .30	25C1682 .25 .30 .35	25D337 .60 .70 .80	HA1588 1.75 1.95 2.20	TA7183P 1.55 1.75 1.95
25A74 30 40	25C727 .20 .27 .30	25C1683 .25 .30 .35	25D338 .60 .70 .80	HA1589 1.75 1.95 2.20	TA7184P 1.55 1.75 1.95
25A75 30 40	25C728 .20 .27 .30	25C1684 .25 .30 .35	25D339 .60 .70 .80	HA1590 1.75 1.95 2.20	TA7185P 1.55 1.75 1.95
25A76 30 40	25C729 .20 .27 .30	25C1685 .25 .30 .35	25D340 .60 .70 .80	HA1591 1.75 1.95 2.20	TA7186P 1.55 1.75 1.95
25A77 30 40	25C730 .20 .27 .30	25C1686 .25 .30 .35	25D341 .60 .70 .80	HA1592 1.75 1.95 2.20	TA7187P 1.55 1.75 1.95
25A78 30 40	25C731 .20 .27 .30	25C1687 .25 .30 .35	25D342 .60 .70 .80	HA1593 1.75 1.95 2.20	TA7188P 1.55 1.75 1.95
25A79 30 40	25C732 .20 .27 .30	25C1688 .25 .30 .35	25D343 .60 .70 .80	HA1594 1.75 1.95 2.20	TA7189P 1.55 1.75 1.95
25A80 30 40	25C733 .20 .27 .30	25C1689 .25 .30 .35	25D344 .60 .70 .80	HA1595 1.75 1.95 2.20	TA7190P 1.55 1.75 1.95
25A81 30 40	25C734 .20 .27 .30	25C1690 .25 .30 .35	25D345 .60 .70 .80	HA1596 1.75 1.95 2.20	TA7191P 1.55 1.75 1.95
25A82 30 40	25C735 .20 .27 .30	25C1691 .25 .30 .35	25D346 .60 .70 .80	HA1597 1.75 1.95 2.20	TA7192P 1.55 1.75 1.95
25A83 30 40	25C736 .20 .27 .30	25C1692 .25 .30 .35	25D347 .60 .70 .80	HA1598 1.75 1.95 2.20	TA7193P 1.55 1.75 1.95
25A84 30 40	25C737 .20 .27 .30	25C1693 .25 .30 .35	25D348 .60 .70 .80	HA1599 1.75 1.95 2.20	TA7194P 1.55 1.75 1.95
25A85 30 40	25C738 .20 .27 .30	25C1694 .25 .30 .35	25D349 .60 .70 .80	HA1600 1.75 1.95 2.20	TA7195P 1.55 1.75 1.95
25A86 30 40	25C739 .20 .27 .30	25C1695 .25 .30 .35	25D350 .60 .70 .80	HA1601 1.75 1.95 2.20	TA7196P 1.55 1.75 1.95
25A87 30 40	25C740 .20 .27 .30	25C1696 .25 .30 .35	25D351 .60 .70 .80	HA1602 1.75 1.95 2.20	TA7197P 1.55 1.75 1.95
25A88 30 40	25C741 .20 .27 .30	25C1697 .25 .30 .35	25D352 .60 .70 .80	HA1603 1.75 1.95 2.20	TA7198P 1.55 1.75 1.95
25A89 30 40	25C742 .20 .27 .30	25C1698 .25 .30 .35	25D353 .60 .70 .80	HA1604 1.75 1.95 2.20	TA7199P 1.55 1.75 1.95
25A90 30 40	25C743 .20 .27 .30	25C1699 .25 .30 .35	25D354 .60 .70 .80	HA1605 1.75 1.95 2.20	TA7200P 1.55 1.75 1.95
25A91 30 40	25C744 .20 .27 .30	25C1700 .25 .30 .35	25D355 .60 .70 .80	HA1606 1.75 1.95 2.20	TA7201P 1.55 1.75 1.95
25A92 30 40	25C745 .20 .27 .30	25C1701 .25 .30 .35	25D356 .60 .70 .80	HA1607 1.75 1.95 2.20	TA7202P 1.55 1.75 1.95
25A93 30 40	25C746 .20 .27 .30	25C1702 .25 .30 .35	25D357 .60 .70 .80	HA1608 1.75 1.95 2.20	TA7203P 1.55 1.75 1.95
25A94 30 40	25C747 .20 .27 .30	25C1703 .25 .30 .35	25D358 .60 .70 .80	HA1609 1.75 1.95 2.20	TA7204P 1.55 1.75 1.95
25A95 30 40	25C748 .20 .27 .30	25C1704 .25 .30 .35	25D359 .60 .70 .80	HA1610 1.75 1.95 2.20	TA7205P 1.55 1.75 1.95
25A96 30 40	25C749 .20 .27 .30	25C1705 .25 .30 .35	25D360 .60 .70 .80	HA1611 1.75 1.95 2.20	TA7206P 1.55 1.75 1.95
25A97 30 40	25C750 .20 .27 .30	25C1706 .25 .30 .35	25D361 .60 .70 .80	HA1612 1.75 1.95 2.20	TA7207P 1.55 1.75 1.95
25A98 30 40	25C751 .20 .27 .30	25C1707 .25 .30 .35	25D362 .60 .70 .80	HA1613 1.75 1.95 2.20	TA7208P 1.55 1.75 1.95
25A99 30 40	25C752 .20 .27 .30	25C1708 .25 .30 .35	25D363 .60 .70 .80	HA1614 1.75 1.95 2.20	TA7209P 1.55 1.75 1.95
25A100 30 40	25C753 .20 .27 .30	25C1709 .25 .30 .35	25D364 .60 .70 .80	HA1615 1.75 1.95 2.20	TA7210P 1.55 1.75 1.95
25A101 30 40	25C754 .20 .27 .30	25C1710 .25 .30 .35	25D365 .60 .70 .80	HA1616 1.75 1.95 2.20	TA7211P 1.55 1.75 1.95
25A102 30 40	25C755 .20 .27 .30	25C1711 .25 .30 .35	25D366 .60 .70 .80	HA1617 1.75 1.95 2.20	TA7212P 1.55 1.75 1.95
25A103 30 40	25C756 .20 .27 .30	25C1712 .25 .30 .35	25D367 .60 .70 .80	HA1618 1.75 1.95 2.20	TA7213P 1.55 1.75 1.95
25A104 30 40	25C757 .20 .27 .30	25C1713 .25 .30 .35	25D368 .60 .70 .80	HA1619 1.75 1.95 2.20	TA7214P 1.55 1.75 1.95
25A105 1.05 1.15	25C758 .20 .27 .30	25C1714 .25 .30 .35	25D369 .60 .70 .80	HA1620 1.75 1.95 2.20	TA7215P 1.55 1.75 1.95
25A106 30 40	25C759 .20 .27 .30	25C1715 .25 .30 .35	25D370 .60 .70 .80	HA1621 1.75 1.95 2.20	TA7216P 1.55 1.75 1.95
25A107 30 40	25C760 .20 .27 .30	25C1716 .25 .30 .35	25D371 .60 .70 .80	HA1622 1.75 1.95 2.20	TA7217P 1.55 1.75 1.95
25A108 30 40	25C761 .20 .27 .30	25C1717 .25 .30 .35	25D372 .60 .70 .80	HA1623 1.75 1.95 2.20	TA7218P 1.55 1.75 1.95
25A109 30 40	25C762 .20 .27 .30	25C1718 .25 .30 .35	25D373 .60 .70 .80	HA1624 1.75 1.95 2.20	TA7219P 1.55 1.75 1.95
25A110 30 40	25C763 .20 .27 .30	25C1719 .25 .30 .35	25D374 .60 .70 .80	HA1625 1.75 1.95 2.20	TA7220P 1.55 1.75 1.95
25A111 30 40	25C764 .20 .27 .30	25C1720 .25 .30 .35	25D375 .60 .70 .80	HA1626 1.75 1.95 2.20	TA7221P 1.55 1.75 1.95
25A112 30 40	25C765 .20 .27 .30	25C1721 .25 .30 .35	25D376 .60 .70 .80	HA1627 1.75 1.95 2.20	TA7222P 1.55 1.75 1.95
25A113 30 40	25C766 .20 .27 .30	25C1722 .25 .30 .35	25D377 .60 .70 .80	HA1628 1.75 1.95 2.20	TA7223P 1.55 1.75 1.95
25A114 30 40	25C767 .20 .27 .30	25C1723 .25 .30 .35	25D378 .60 .70 .80	HA1629 1.75 1.95 2.20	TA7224P 1.55 1.75 1.95
25A115 30 40	25C768 .20 .27 .30	25C1724 .25 .30 .35	25D379 .60 .70 .80	HA1630 1.75 1.95 2.20	TA7225P 1.55 1.75 1.95
25A116 30 40	25C769 .20 .27 .30	25C1725 .25 .30 .35	25D380 .60 .70 .80	HA1631 1.75 1.95 2.20	TA7226P 1.55 1.75 1.95
25A117 30 40	25C770 .20 .27 .30	25C1726 .25 .30 .35	25D381 .60 .70 .80	HA1632 1.75 1.95 2.20	TA7227P 1.55 1.75 1.95
25A118 30 40	25C771 .20 .27 .30	25C1727 .25 .30 .35	25D382 .60 .70 .80	HA1633 1.75 1.95 2.20	TA7228P 1.55 1.75 1.95
25A119 30 40	25C772 .20 .27 .30	25C1728 .25 .30 .35	25D383 .60 .70 .80	HA1634 1.75 1.95 2.20	TA7229P 1.55 1.75 1.95
25A120 30 40	25C773 .20 .27 .30	25C1729 .25 .30 .35	25D384 .60 .70 .80	HA1635 1.75 1.95 2.20	TA7230P 1.55 1.75 1.95
25A121 30 40	25C774 .20 .27 .30	25C1730 .25 .30 .35	25D385 .60 .70 .80	HA1636 1.75 1.95 2.20	TA7231P 1.55 1.75 1.95
25A122 30 40	25C775 .20 .27 .30	25C1731 .25 .30 .35	25D386 .60 .70 .80	HA1637 1.75 1.95 2.20	TA7232P 1.55 1.75 1.95
25A123 30 40	25C776 .20 .27 .30	25C1732 .25 .30 .35	25D387 .60 .70 .80	HA1638 1.75 1.95 2.20	TA7233P 1.55 1.75 1.95
25A124 30 40	25C777 .20 .27 .30	25C1733 .25 .30 .35	25D388 .60 .70 .80	HA1639 1.75 1.95 2.20	TA7234P 1.55 1.75 1.95
25A125 30 40	25C778 .20 .27 .30	25C1734 .25 .30 .35	25D389 .60 .70 .80	HA1640 1.75 1.95 2.20	TA7235P 1.55 1.75 1.95
25A126 30 40	25C779 .20 .27 .30	25C1735 .25 .30 .35	25D390 .60 .70 .80	HA1641 1.75 1.95 2.20	TA7236P 1.55 1.75 1.95
25A127 30 40	25C780 .20 .27 .30	25C1736 .25 .30 .35	25D391 .60 .70 .80	HA1642 1.75 1.95 2.20	TA7237P 1.55 1.75 1.95
25A128 30 40	25C781 .20 .27 .30	25C1737 .25 .30 .35	25D392 .60 .70 .80	HA1643 1.75 1.95 2.20	TA7238P 1.55 1.75 1.95
25A129 30 40	25C782 .20 .27 .30	25C1738 .25 .30 .35	25D393 .60 .70 .80	HA1644 1.75 1.95 2.20	TA7239P 1.55 1.75 1.95
25A130 30 40	25C783 .20 .27 .30	25C1739 .25 .30 .35	25D394 .60 .70 .80	HA1645 1.75 1.95 2.20	TA7240P 1.55 1.75 1.95
25A131 30 40	25C784 .20 .27 .30	25C1740 .25 .30 .35	25D395 .60 .70 .80	HA1646 1.75 1.95 2.20	TA7241P 1.55 1.75 1.95
25A132 30 40	25C785 .20 .27 .30	25C1741 .25 .30 .35	25D396 .60 .70 .80	HA1647 1.75 1.95 2.20	TA7242P 1.55 1.75 1.95
25A133 30 40	25C786 .20 .27 .30	25C1742 .25 .30 .35	25D397 .60 .70 .80	HA1648 1.75 1.95 2.20	TA7243P 1.55 1.75 1.95
25A134 30 40	25C787 .20 .27 .30	25C1743 .25 .30 .35	25D398 .60 .70 .80	HA1649 1.75 1.95 2.20	TA7244P 1.55 1.75 1.95
25A135 3					



PTS 8001 Component Analyzer

Solid state component tester
works in or out of circuit. Simple
hook-up to any standard oscilloscope.
High, medium and low range switch for matching
the impedance to the component being tested.
Dealer Net \$54.95

See the Yellow Pages for the PTS Servicer Center Nearest You or Contact:



PTS ELECTRONICS, INC.

P.O. Box 272 Bloomington, IN 47401 812-824-9331

CIRCLE 66 ON FREE INFORMATION CARD

**REGULATED
POWER SUPPLIES**
POWER SYSTEMS # P51111
115-220V 50/60 Hz. in VAC at 35A out.
6% 16% 15% 26 lbs. shipping weight \$85.00
POWER SYSTEMS # P51106
115-220V 50/60 Hz. in 12 VAC at 15A out.
5% 16% 5% 19 lbs. shipping weight. \$75.00

C/MOS (DIODE CLAMPED)
4001 18 4019 37 4046 35 74C124 46
4002 18 4020 39 4050 36 74C263 115
4006 35 4011 40 4093 110 74C280 40
4007 37 4022 38 4090 115 74C283 75
4011 18 4025 38 4096 115 74C161 140
4010 37 4028 37 4071 110 74C160 105
4012 18 4026 38 4096 115 74C161 140
4013 18 4027 37 4070 110 74C174 105
4014 18 4028 38 4096 115 74C174 105
4015 18 4029 39 74C162 22 74C193 120
4016 18 4030 39 74C162 22 74C193 120
4017 18 4031 39 74C162 22 74C193 120
4018 18 4032 39 74C162 22 74C193 120
4019 18 4033 39 74C162 22 74C193 120
4020 18 4034 39 74C162 22 74C193 120

PRINTED CIRCUIT BOARD
4 1/2" x 6 1/2" SINGLE SIDE EPOXY
BOARD 1 IN. 16% 10% 10% 10%
\$30.00 5/52.00
7 WATT LED 65 LASER DIODE 1R \$8.95
2N 3020 P-FET \$.45
2N 3027 N-FET \$.45
2N2646 UJT \$.45
EH 100 TRIGGER DIODES \$ 1.00
2N 2028 PNP UJT \$.65

MINIATURE MULTI-TURN TRIM POT
100, 1K, 2K, 5K, 10K, 20K, 50K, 100K
200K, 500K, 1M, 2M, 5M \$7.5 each \$32.00
CHARGED COUPLED DEVICES
CCD 201C 100-100 Image Sensor \$95.00
CCD 202C 100-100 Image Sensor \$145.00
VERIPAX PC BOARD \$4.00
This board is a 1/4" single sided board
board, 40% 40% DRILLED AND ETCHED WHICH
will hold up to 21 single 14 pin IC's or 6 1/2" LPT
DIP IC's with traces for power supply connection.

RF 100 PHOTO TRANS \$.50
RED, YELLOW, GREEN OR AMBER
LARGE LED'S \$.65/100
TTL-TTL OPTO ISOLATOR \$.75
MCT-6 OPTO ISOLATOR \$.80
1 WATT ZENER'S 3.3, 4.7, 5.1, 5.6, 9.1, 10
12, 15, 18, OR 22V \$.65/100
MC8080 MODEM CHIP \$.99/5
MCM 8071A 7 x 9 character gen. \$10.75

Silicon Power Rectifiers
PRV 1A 3A 12A 50A 125A 200A
100 106 14 30 35 80 330 600
200 37 70 75 115 425 550
400 19 26 50 60 65 90 120
800 15 35 70 100 150 160
1000 20 60 110 215 125 200 400
\$20 100A x REVERSE 100A surge energy
triangular pulse rating \$14.95
(N 4148 1N914) 15 \$1.30

REGULATORS
309K \$1.20 340K 1215
723 \$1.00 24V \$.95
LM 317 \$.60 340F 6, 8, 12
3207 \$.60 1518 or 24V 9.5
\$ 1.25
\$ 1.25 \$.78 79 MM \$1.35

TRANSISTOR SPECIALS
2N6213 PNP 50 Ohm Power \$1.95
MRF-8004 4 CBR RF Transistor NPN \$.75
2N1712 NPN 5 TO 3 \$ 1.00
2N1646 PNP GE TO 13 \$.75
2N4909 PNP TO 13 \$ 1.00
2N4909 PNP TO 13 \$ 1.00
2N5086 PNP 5 TO 92 \$ 4.50
2N5139 NPN 5 TO 3 \$.55
2N3919 NPN 5 TO 3 \$.50
2N1420 NPN 5 TO 5 \$ 3.00
2N1781 NPN 5 TO 66 \$.70
2N2222 NPN 5 TO 18 \$ 5.00
2N2056 NPN 5 TO 3 \$.90
2N3004 NPN 5 TO 92 \$ 6.00
2N3006 PNP 5 TO 92 \$ 6.00
2N2996 NPN 5 TO 220 \$.50
2N4010 PNP 5 TO 230 \$.55
2N3036 PNP 5 TO 5 \$ 1.00
MPSA 13 NPN 5B \$.60

Full Wave Bridges
22A 5A 15A 25A
8 PIN 17 24 PIN 35
200 75 175 200
400 150 300 350
600 120 175 400
18 PIN 25

SANKEN AUDIO POWER AMPS
5 10K 10 WATTS \$ 1.80
5 10K 20 WATTS \$ 1.70
5 10K 50 WATTS \$ 2.50

TANTULUM CAPACITORS
22UF 35V 5 S100 6.8UF 35V 4 S100
47UF 35V 5 S100 10UF 10V \$.25
68UF 35V 5 S100 22UF 20V \$.40
1UF 25V 5 S100 10UF 30V 5 S100
2.2UF 20V 5 S100 30UF 0V 5 S100
5UF 20V 4 S100 68UF 20V \$.35
4.7UF 15V 5 S100 47UF 15V \$.50
100 100 100 100

TLT IC SERIES
4001 18 4019 37 4046 35 74C124 46
4002 18 4020 39 4050 36 74C263 115
4006 35 4011 40 4093 110 74C280 40
4007 37 4022 38 4090 115 74C283 75
4011 18 4025 38 4096 115 74C161 140
4010 37 4028 37 4071 110 74C160 105
4012 18 4026 38 4096 115 74C161 140
4013 18 4027 37 4070 110 74C174 105
4014 18 4028 38 4096 115 74C174 105
4015 18 4029 39 74C162 22 74C193 120
4016 18 4030 39 74C162 22 74C193 120
4017 18 4031 39 74C162 22 74C193 120
4018 18 4032 39 74C162 22 74C193 120
4019 18 4033 39 74C162 22 74C193 120
4020 18 4034 39 74C162 22 74C193 120

DATA CASCATES 1/2 HR \$.95
22/44 Pin Solder Tail 150F Conn. \$1.95
MM 5387A 48 pin clock chip which will directly
drive LED's 1/24 Hz, 1 supply & alarm \$5.95

7244 Pin Solder Tail 150F Conn. \$1.95
MM 5387A 48 pin clock chip which will directly
drive LED's 1/24 Hz, 1 supply & alarm \$5.95

NO. 30 WIRE WRAPE SINGLE
ETERNAL 100 \$1.40
ALCO MINUTE TOGGLE SWITCHES
MTA 106 SPOT \$.95
MTA 206 SPOT \$ 1.20
MTA 206 P-DOT CENTER OFF \$ 1.85
MTA 206 P-DOT CENTER OFF \$ 1.85

DATA CASCATES 1/2 HR \$.95
22/44 Pin Solder Tail 150F Conn. \$1.95
MM 5387A 48 pin clock chip which will directly
drive LED's 1/24 Hz, 1 supply & alarm \$5.95

TRACS
PRV 1A 3A 12A 50A 125A 200A
100 106 14 30 35 80 330 600
200 37 70 75 115 425 550
400 19 26 50 60 65 90 120
800 15 35 70 100 150 160
1000 20 60 110 215 125 200 400

**WE SHIP OVER 95%
OF OUR ORDERS THE
DAY WE RECEIVE THEM**

CIRCLE 21 ON FREE INFORMATION CARD

**12V 8A
POWER SUPPLY
\$44.50**

Handles 12A with 50% duty cycle. Hams and CBers
use it for powering mobile transceivers in the home, techs
use it for a bench supply. Hi-Fi stores use it to power
stereo equipment, and computer owners use it to power
bunches of floppy disc drives. Features crowbar over-
voltage protection, loadback current limiting, adjustable
output 11-14V, custom heavy-duty transformer, RF sup-
pression, and easy assembly (all parts except x-former/filter
caps/diodes mount on circuit board). With complete
assembly instructions. Does not include case.

TRS-80 COMPATIBLE 12K X 8 MEMORY BOARD UNKIT \$200

Includes DIP chips, 250 no upgrades for 4 Mhz operation,
and 1 year guarantee. Upgrades for TRS-80 to 15K,
or populates Memory Expansion Module - our novice level
instructions show you how. Also suitable for APPLE com-
puters.

88 COMPATIBLE 12K X 8 MEMORY BOARD UNKIT \$200

Comes with sockets and bypass caps pre-soldered in
place for easy assembly. Fully static buffered, and
includes on-board regulation. With easy-to-follow instruc-
tions.

MEMORY SPECIAL: 2101-1L (high speed/low
power) 1K STATIC RAM NOW ONLY 99¢ EACH
(sorry, only good for orders of 10 or more)

GOODBOY ELECTRONICS
BOX 2355 CAULFIELD ABBEY, CA 94514
TERMS: Orders under \$15 add \$1. Cal res add VISA/Master-
charge. (\$15 min) call (415) 862-0636, 24 hrs. Allow 5% shipping.
Orders shipped 100% cash advance by money order.

GO FOR YOUR FREE FLYER

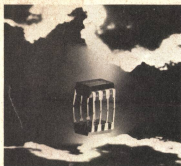
CIRCLE 28 ON FREE INFORMATION CARD

Terms: FOB Cambridge, Mass.
Send Check or Money Order
Include Postage, Minimum
Order \$5.00, CDP \$33.00

Send 25¢ for our catalog featuring
Transistors and Rectifiers
145 Hampshire St., Cambridge, Mass.

SOLID STATE SALES
P.O. BOX 74
SOMERVILLE, MASS. 02143 TEL. (617) 547-7053

CIRCLE 21 ON FREE INFORMATION CARD



THE NEW HOBBY WORLD CATALOG

Your source for factory prime, professional quality equipment. Computers, add-on boards, IC's, sockets, resistors, supplies, tools, test equipment,

books, and more. Shop your buy list at Hobby World. You'll find what you want, and at a solid savings. For example, look at this month's specials:

NEW FROM CALIFORNIA COMPUTER SYSTEMS!

16K STATIC RAM KIT, MODEL XVI.

IEEE S-100 compatible, requires only +5 Volts, 450 ns, fully buffered. Bank switching capability. Phantom line, wait state, addressable in 4K blocks.

HOBBY WORLD PRICE ONLY \$265 KIT, \$27 BARE BOARD

16K MEMORY ADD-ON FOR APPLE, TRS-80 OR EXIDY SORCERER

HOBBY WORLD PRICE ONLY \$98 (specify when ordering)

C-10 DATA CASSETTES - PERFECT FOR TRS-80

PRICE ONLY \$2 EACH! 10 for \$17.50

SEND ME A FREE CATALOG!

Name _____

Address _____

City _____

State _____

Hobby World
19355 Business Center Dr #6
Northridge CA 91324

TELEPHONE ORDERS
Inside Cal 213 886 9200
Outside Cal 800 423 5387

CIRCLE 44 ON FREE INFORMATION CARD

CATCH-A-PULSE II LOGIC PROBE

**10 Nsec SPEED AT
4 to 15 LEVELS**



ONLY
\$44.95

Compatible with DTL, TTL, CMOS, MOS, and Microprocessors using a 4 to 15V power supply. Thresholds automatically programmed. Automatic resetting memory. No adjustment required. Visual indication of logic levels, using LEDs to show high, low, bad level or open circuit logic and pulses. Highly sophisticated, shirt pocket portable (protective tip cap and removable coil cord). Eliminates need for heavy test equipment. A definite savings in time and money for engineer and technician.

- 10 Nsec pulse response
- Open circuit detection
- Replaceable tip & cord
- High input impedance
- Pulse stretching
- Multi-family

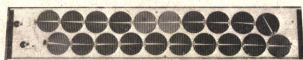
SPECIAL PACKAGE \$51.95

Includes a standard coiled cord, coiled cord with micro hooks, adapter for using CATCH-A-PULSE on logic families whose power supply is 15V to 25V. Shipping add \$2.00 per probe.

AV ELECTRONICS
Box 19299, San Diego, CA 92119

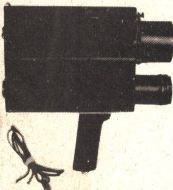
(714) 447-1770

CIRCLE 11 ON FREE INFORMATION CARD



Solar cell panels, used, OK condition

20 cell panel, 2" cells 6 volt 1/2 amp	\$ 75.00
36 cell panel, 12 volt 1/2 amp	100.00
24 cell panel, 8 volt .45 amp	85.00
10 half cell panel, 5 volt 1/2 amp	50.00
5 cell panel, 2.5 volt 1/2 amp	40.00
Single 3.5 inch cell, 1 amp, .45 volt	8.50
Solar power kit, 3.5 inch cell, motor, propeller..	\$ 10.25
ULTRASONIC room alarm, intrusion detection with full data for hookup	40.00



SEE IN THE DARK
IR viewer complete ready to operate. Guaranteed by the manufacturer. Portable, runs on lantern battery. New, see in total darkness. No shipments to Calif. Comes complete with built in IR source and adjustable focus lens.
SPL-21 \$199.00

All items FOB Lynn, Mass. Send for free 64 page catalog jam packed with goodies.

Meshna Inc., PO Box 62, E. Lynn, Mass. 01904

CIRCLE 32 ON FREE INFORMATION CARD

INTEGRATED ELECTRONICS

540 Weddell Drive, #4, Sunnyvale, CA 94086 (408)734-8470

SN6477 Complex Sound Generator \$3.50

This is a programmable sound effect generator capable of producing a wide variety of sounds from high to low frequency. Using this chip & a small number of inexpensive parts, a variety of projects may be built. Spec shs & application notes \$1.00

TL500 Analog Processor \$8.50

The TL500 contains all the active analog elements for an automatic zeroing and automatic polarity. It is a 13-bit dual-slope A/D converter that has true differential inputs. It requires 3 caps. & 2 resistors with no special matching or tolerances. It is designed for use with the TL502. Spec sheet \$.25

TL502 Digital Panel Meter L.D. \$5.50

This is a 4 1/2-digit Digital Panel Meter L.D. that is designed to interface with the TL500 analog processor. It provides base drive for external PNP digit & segment drivers providing direct interface with 7-segment display. Spec sheet \$.25

LD130 A/D Converter \$5.50

Single-reference voltage, auto zero and auto polarity. It is designed for Digital Voltmeters, Panel Meters, Digital Thermometers, Microprocessor Interfaces to Analog Signals, & General Instrumentation. 34-pg. Spec & Application notes \$2.50

MM5865 Programmable Stopwatch \$7.50

7-function Universal Timer and Stopwatch. Start/stop with elapsed time, start/stop accumulative event time, split, sequential total elapsed time, rally total elapsed time, program up and down count. It uses 32.8 KHz crystal or external clock. Spec sheet & 10-page Application notes \$1.50

32.8 KHz Crystal \$4.00

Minimum order \$5.00 US currency. Check or money order only. Add 5% to cover shipping and handling charges. Calif. residents add 6% sales tax. Santa Clara County residents add 6.5% sales tax.

CIRCLE 48 ON FREE INFORMATION CARD

KITS • KITS • KITS

NEW . . . PRE-DRILLED PCB's FOR ALL 100 SERIES KITS

Perforated Boards NOT INCLUDED w/100 Series



103 MINI-WINK NEON FLASHER. Random flash pattern. Interesting displays. 6 neon lamps. AC operated.

103 \$2.95
103A (103 w/PCB) 4.60
103B (103 w/PCB, CASE) 6.85



110 ELECTRONIC WHOOPER SIREN. Powerful wailing sound. Dual oscillator circuit. Use with any alarm circuit. Battery not included.

110 \$4.95
110A (110 w/PCB) 6.50
110B (110 w/PCB, CASE) 9.60



117 TUNABLE ELECTRONIC ORGAN. Tunable 7-note scale. Play sing-a-long favorites. Battery not included.

117 \$6.95
117A (117 w/PCB) 8.90
117B (117 w/PCB, CASE) 12.00



120 SIREN/CODE OSCILLATOR. Loud, piercing alarm. Practice Morse code. Battery not included.

120 \$4.20
120A (120 w/PCB) 5.55
120B (120 w/PCB, CASE) 8.65



104 VARIABLE STROBE LIGHT. Great for parties and photography. Variable flash rate. AC operated.

104 \$9.95
104A (104 w/PCB) 14.20
104B (104 w/PCB, CASE) 19.70



126 PROGRAMMABLE DOORBELL. Adjustable rate and pitch for 15 musical notes. Play favorite tunes, 6 IC's. Uses existing transformer and switch.

126 \$16.95
126A (126 w/PCB) 23.70
126B (126 w/PCB, CASE) 29.20

Perforated Boards NOT INCLUDED w/100 Series



109 AUTO/HOME BURGLAR ALARM. Use with car horn or models 110 or 124 sirens. Latching circuit. Battery not included.

109 \$2.25
109A (109 w/PCB) 3.40
109B (109 w/PCB, CASE) 5.00

114 AUDIO AMPLIFIER. High sensitivity, high gain, use as intercom, PA amp, phone pick-up and others, push-pull output. Battery not included.

114 \$6.35
114A (114 w/PCB) 8.90
114B (114 w/PCB, CASE) 12.00



102 6/9 VOLT SUPPLY. 100mA. Battery eliminator, dual range output switch, neon pilot lamp. AC operated.

102 \$3.95
102A (102 w/PCB) 5.30
102B (102 w/PCB, CASE) 7.25

119 MOTOR SPEED CONTROL. Adjust motor speed to suit application. SCR controlled, use as light dimmer. AC operated.

119 \$3.95
119A (119 w/PCB) 5.50
119B (119 w/PCB, CASE) 7.75



123 ELECTRONIC TIMER. Turns appliances on and off, adjustable control, 2 minutes to 1 hour. 1 IC, AC operated.

123 \$8.95
123A (123 w/PCB) 11.40
123B (123 w/PCB, CASE) 13.65

540 BINARY CLOCK. Handcraft tomorrow's timepiece today. Watch constantly changing patterns of LED's as they display Binary Time. This unique clock project enhances the learning of Digital Logic and the Binary Coding System, as well as offering a beautifully styled conversation piece.

10 CT INTEGRATED CIRCUITS • VOLTAGE REGULATOR • 43,000 PULSATING LIGHT PATTERNS • FAST, SLOW AND HOLD CONTROLS • 115VAC 50 or 60Hz.



\$39.95 Complete with 80 page manual

536 8-TRANSISTOR AM RADIO. Experience jewel-like clarity in sound. The best superheterodyne kit circuit available. SEPARATE LOCAL OSCILLATOR for high sensitivity and excellent selectivity. Unique IF Transformer mounting system. 9V battery required (not included).



\$16.45 Complete with 88 page manual

Perforated Boards NOT INCLUDED w/100 Series



124 WARBLING SIREN. Two-tone oscillating siren. Loud and penetrating, 2 IC's. For automobile or other 12 volt systems.

124 \$5.65
124A (124 w/PCB) 7.10
124B (124 w/PCB, CASE) 10.20



105 FISH CALLER. Clicking sound imitates distressed fish. Adjustable speed. Battery not included.

105 \$2.95
105A (105 w/PCB) 4.10
105B (105 w/PCB, CASE) 5.70



107 COLOR ORGAN CONTROL — 3 CHANNEL. Over 200W per channel. Separate sensitivity control. Hi-mid-lo frequency response. AC operated.

107 \$9.20
107A (107 w/PCB) 11.85
107B (107 w/PCB, CASE) 14.95



118 TV SCRAMBLER. Tunable to all VHF stations. 30 foot range. Battery not included.

118 \$1.95
118A (118 w/PCB) 2.90
118B (118 w/PCB, CASE) 4.50



122 COMPUTER SOUND EFFECTS GENERATOR. Produces weird, spacey sounds. 4 IC's. Control tone, rate and blip or glide. Battery not included.

122 \$14.95
122A (122 w/PCB) 19.40
122B (122 w/PCB, CASE) 24.90

We accept:

VISA,



MASTER CHARGE BANKAMERICARD

CALL TOLL FREE

800-824-5136

IN CALIFORNIA CALL 800-852-7631

ASK FOR OPERATOR 318

DO NOT SEND CASH • NO COD • ORDER BY PHONE OR MAIL

CALIF. RESIDENTS ADD 6% SALES TAX.

MINIMUM ORDER \$10.00

WE PAY POSTAGE AND HANDLING

IN U.S.A. OVERSEAS COUNTRIES:

ADD 15% OF TOTAL FOR POSTAGE.

SEND CHECK OR

MONEY ORDER TO:

Graymark International, Inc.

1751 McGaw Avenue Dept. 2 Irvine, CA 92714 (714) 540-5480

ALL NEW

Real-State-of-the-Art

TWO NEW AC•DC•BATTERY PORTABLE COUNTERS

OPTO-8000 .1A 10Hz to 600 MHz — FREQUENCY COUNTER

- Precision TCXO time base 0.1 PPM Stability 17-40°C
- Super Sensitivity with preamps in both HI-Z & 50 Ohm inputs <10mV to 50MHz, 25 mV @ 150 MHz <50mV to 600MHz
- Auto Decimal Point • Aluminum Case • Socketed IC's
- Three position attenuator: X1, X10, X100 (avoids false counting)

#OPTO-8000.1A	Factory Assembled	\$329.95
#OPTO-8000.1AK	Kit Form	\$279.95
#NI-CAD-80	NI-CAD Battery Pack	\$ 19.95

OPTO-7000 10 Hz to 600 MHz MINIATURE COUNTER

- XTAL (TCXO) Time Base $\pm .08$ PPM/°C
 - Aluminum Case • HI-Z & 50 Ohm inputs
 - 1 Sec. & 1/10 Sec. Gate times • Auto Dec. Pt.
 - Built-in Prescaler and Preamps Standard
- | | | |
|-------------|--|----------|
| #OPTO-7000 | Factory Assembled - 1 Year-Guar .. | \$139.95 |
| #OPTO-7000K | Kit Form | 99.95 |
| #AC-70 | AC Power Pack | 4.95 |
| #NI-CAD-70 | NI-CAD Battery Pack | 19.95 |
| #TCXO-70 | Precision TCXO Time Base
<0.1PPM, 17-40°C | 79.95 |

ACCESSORIES

PROBES:

#P-100	50 Ohm, 1X	\$13.95
#P-101	Lo-Pass	16.95
#P-102	H1-Z, 2X	16.95
#AP-8015	UHF Counter Preamp 20 MHz to 600 MHz 15-50 DB Gain (Not Shown) ..	\$49.95/Kit \$39.95

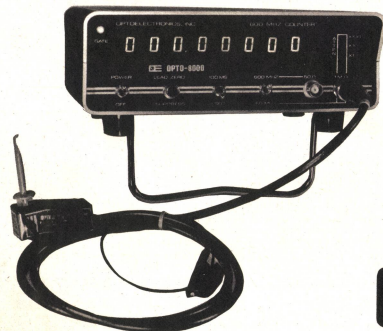
#D-450 Antenna

Rubber Duck RF Pick-up 450 MHz ... \$12.50

#D-146 Same as above

146.5MHz

#RA-BNC Right-Angle BNC Adapter for
above Antenna



OPTOELECTRONICS, INC.

5821 NE 14 Avenue
FL Lauderdale, FL 33334
Phones: (305) 771-2050 771-2051

Phone orders accepted

ORDER FACTORY DIRECT — PHONE OR MAIL

TERMS: Orders to U.S. and Canada, add 5% to maximum of \$10.00 per order for shipping, handling and insurance. To all other countries, add 10% of total order. Florida residents add 4% state tax. C.O.D. fee: \$1.00. Personal checks must clear before merchandise is shipped.

COMPUTER INTERFACES & PERIPHERALS

For free catalog including parts lists and schematics, send a self-addressed stamped envelope.

APPLE II SERIAL I/O INTERFACE *

Part no. 2
Baud rate is continuously adjustable from 0 to 30,000 • Plugs into any peripheral connector • Low current drain, RS-232 input and output • On board switch selectable 5 to 8 data bits, 1 or 2 stop bits, and parity or no parity either odd or even • Jumper selectable address • SOFTWARE • Input and Output routine from monitor or BASIC to teletype or other serial printer • Program for using an Apple II for a video or an intelligent terminal. Also can output in correspondence code to interface with some electrics. Board only — \$15.00, with parts — \$42.00; assembled and tested — \$62.00.



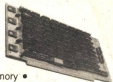
T.V. TYPEWRITER

Part no. 106
• Stand alone TVT • 32 char/line, 16 lines, modifications for 64 char/line included • Parallel ASCII (TTL) input • Video output • 1K on board memory • Output for computer controlled cursor • Auto scroll • Non-destructive cursor • Cursor inputs: up, down, left, right, home, EOL, EOS • Scroll up, down • Requires 5 volts at 1.5 amps, and -12 volts at 30 mA • All 7400, TTL chips • Char. gen. 2513 • Upper case only • Board only \$39.00; with parts \$145.00



8K STATIC RAM

Part no. 300
• 8K Altair bus memory • Uses 2102 Static memory chips • Memory protect • Gold contacts • Wait states • On board regulator • S-100 bus compatible • Vector input option • TRI state buffered • Board only \$22.50; with parts \$160.00



RF MODULATOR *

Part no. 107
• Converts video to AM modulated RF, Channels 2 or 3. So powerful almost no tuning is required. On board regulated power supply makes this extremely stable. Rated very highly in Doctor Dobbs' Journal. Recommended by Apple. • Power required is 12 volts AC C.T. or +5 volts DC • Board \$7.60; with parts \$13.50

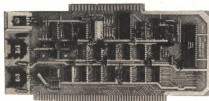


MODEM *

Part no. 109
• Type 103 • Full or half duplex • Works up to 300 baud • Originate or Answer • No coils, only low cost components • TTL input and output—serial • Connect 8 ohm speaker and crystal mic. directly to board • Uses XR FSK demodulator • Requires +5 volts • Board \$7.60, with parts \$27.50



TIDMA *



DC POWER SUPPLY *

Part no. 6085
• Board supplies a regulated +5 volts at 3 amps, +12, -12, and -5 volts at 1 amp • Power required is 8 volts AC at 3 amps, and 24 volts AC C.T. at 1.5 amps. • Board only \$12.50, with parts excluding transformers \$42.50



RS 232/TTY *

Part no. 600
• Converts RS-232 to 20mA current loop, and 20mA current loop to RS-232 • Two separate circuits • Requires +12 and -12 volts • Board only \$4.50, with parts \$7.00



TAPE INTERFACE *

Part no. 111
• Play and record Kansas City Standard tapes • Converts a low cost tape recorder to a digital recorder • Works up to 1200 baud • Digital in and out are TTL—serial • Output of board connects to mic. in of recorder • Earphone of recorder connects to input on board • No coils • Requires +5 volts, low power drain • Board \$7.60; with parts \$27.50



UART & BAUD RATE GENERATOR *

Part no. 101
• Converts serial to parallel and parallel to serial • Low cost on board baud rate generator • Baud rates 110, 150, 300, 600, 1200, and 2400 • Low power drain +5 volts and -12 volts required • TTL compatible • All characters contain a start bit, 5 to 8 data bits, 1 or 2 stop bits, and either odd or even parity. • All connections go to a 44 pin gold plated edge connector • Board only \$12.00, with parts \$35.00 with connector add \$3.00



RS 232/TTL *

Part no. 232
• Converts TTL to RS-232, and converts RS-232 to TTL • Two separate circuits • Requires -12 and +12 volts • All connections go to a 10 pin gold plated edge connector • Board only \$4.50; with parts \$7.00 with connector add \$2.00



ELECTRONIC SYSTEMS

Dept. RE-9 P.O. Box 21638, San Jose, CA, USA 95151

To Order:

Mention part number and description. For parts kits add "A" to part number. In USA, shipping paid for orders accompanied by check, money order, or Master Charge, BankAmericard, or VISA number, expiration date and signature. Shipping charges added to C.O.D. orders. California residents add 6.5% for tax. Outside USA add 10% for air mail postage. No C.O.D.'s. Checks and money orders must be payable in US dollars. Parts kits include sockets for all ICs, components, and circuit board. Documentation is included with all products. All items are in stock, and will be shipped the day order is received via first class mail. Prices are in US dollars. No open accounts. To eliminate tariff in Canada boxes are marked "Computer Parts". Dealer inquiries invited. 24 Hour Order Line: (408) 226-4064



* Circuits designed by John Bell

VIZ TEST INSTRUMENTS

Formerly
REA
Instruments



Color T.V. Pattern Generator
WR-515A

MODEL **WR-515A**
Reg. \$199.00 OUR PRICE **\$169.15**

- All patterns output RF, if. Video, 750i or 300i.
- Color bars with bar marker, dots, cross-hatch, raster, color.
- Professional "super-bright" white window signal for over-all receiver analysis, with sync. control.
- Ideal for MATV, CATV, CCTV systems.



Scope Dual-Tracer
WM-541A

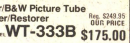
MODEL **WM-541A**
Reg. \$109.00 OUR PRICE **\$91.80**

- Convert single trace scope to dual trace.
- Free response DC to 4 MHz - 3MHz, input impedance 100K ohms.
- Choice of variable "alternate" or "chopped" switch area.
- 1, 2, 5 ratio attenuators, CMRR correction, BNC connectors.
- 150 ohm AC cord.



COLOR PATTERN GENERATOR
WR-508B

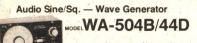
Reg. \$99.00 OUR PRICE **\$59.95**



Color/B&W Picture Tube Tester/Restorer
WT-333B

Reg. \$249.95 OUR PRICE **\$175.00**

- 2 meter design built as three guns of color plus tube to be tested simultaneously.
- Effective cathode-emission restorer adds life to weak pin tubes.
- Measures from 0.2 to 1600 mA AC cathode in 7 ranges.
- Measures peak-to-peak voltages of complex waveforms from 0.5 to 4000 volts in 7 ranges.
- 21-impedance resistance on all DC ranges.
- Accuracy of $\pm 0.5\%$.
- Battery or AC operation.
- Measures from 0.01 mA to 100 mA in 1.5 ranges.
- Supplied with DCAAC F.S. probe with flexible shielded input cable (BNC connector), and current limit loads.
- Measures from 0.2 ohms to 1000 ohms in 7 ranges.
- Measures from 0.01 mA to 1000 mA DC in 8 ranges.



Audio Sine-Sq. - Wave Generator
WA-504B/44D

MODEL **WA-504B/44D**
Reg. \$129.95 OUR PRICE **\$110.50**

- Output 50 Hz to 200 kHz.
- Sine wave harmonic distortion 0.5% up, wave square wave 10% up.
- Voltage output 4 ranges: 0.01 to 50V AC and 0.01 to 50V DC.
- All voltage, through-out, 3 wire AC cord.



RF Signal Generator
WR-50C

MODEL **WR-50C**
Reg. \$170.00 OUR PRICE **\$102.00**

- RF output 0.001 mV, 2 step 10 to 100 MHz.
- Internal Modulating freq. 800 Hz to 800 Hz.
- Audio output 4 ranges: 0.01 to 10V AC and 0.01 to 10V DC.
- P.T.T. amplifier for rugged stability, 3 wire AC cord.



Ruggedized Color Bar Generator
WR-538A

MODEL **WR-538A**
Reg. \$130.00 OUR PRICE **\$75.00**

- Die-cast aluminum outer, tough glass PC board, thick mounted adjusters, optical lamp, 10 to 100 V.
- 100% digital I.C. crystal control.
- Color bars with markers, dots, cross-hatch, super-bright and sync control, 3 wire AC cord.



Senior VoltOhmmyst
WV-98C

MODEL **WV-98C**
Reg. \$139.00 OUR PRICE **\$118.00**



Master VoltOhmmyst
WV-510A

MODEL **WV-510A**
Reg. \$189.00 OUR PRICE **\$143.50**



Master VoltOhmmyst
WV-510A

MODEL **WV-510A**
Reg. \$189.00 OUR PRICE **\$143.50**

- Excellent stability.
- Battery or AC operation.
- Measures from 0.01 mA to 100 mA in 1.5 ranges.
- Measures from 0.2 ohms to 1000 ohms in 7 ranges.
- Measures from 0.01 mA to 1000 mA DC in 8 ranges.



15 Mhz. Trigger Sweep Scope
WO-527A

MODEL **WO-527A**
Reg. \$525.00 OUR PRICE **\$459.25**

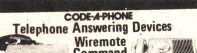


Quick Tracer Transistor/Diode
WC-528B

MODEL **WC-528B**
Reg. \$139.00 OUR PRICE **\$118.00**

Before you buy, check our prices...
Call TOLL FREE (800) 645-9518
N.Y. State call (516) 752-0050

FORDHAM
YOUR ONE STOP DISCOUNT CENTER
Send for our new 1979 catalog over 3,000 items - 164 pages of best equipment.
C.R. tools, tubes, components and electronic supplies.



Telephone Answering Devices
Wiremate Command
Model 1400 **\$199.95**



TV-VTR-MATV and Video Analyzer
Model VA48 **\$875.00**



100 Mhz 8-Digit Counter
Model PS-500 **\$119.00**



3 1/2-Digit Portable DMM
Model 2800 **\$249.95**



Ungar Heat Gun
Model 985 **\$46.50**



Digital Capacitance Meter
Model 520 **\$52.95**



15 Mhz Mini Oscilloscope
Model LM-15 **\$269.95**



Weller Xcelite
Model 100 **\$85.00**



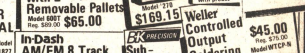
Tranzistorized BSR Changer
Model LCR 740 **\$24.95**



20 Mhz Dual Trace
Model L80 **\$654.50**



Service Master Attache Style
Tool Kit Model 959M **\$42.95**



Hickok Function Generator
Model 218 **\$169.15**



Auto Stereo 40 Watt Power Booster
Model POW-40 **\$24.95**

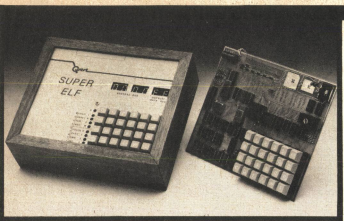


Magnifier Lamp
Model MG 10A **\$49.50**



Trace Scope
Model TR-37 **\$663.00**

FORDHAM
85SR Conlin St. Farmingdale, N.Y. 11735



QUEST Cosmac Super Elf Computer \$106.95

Compare features before you decide to buy any other computer. There is no other computer on the market today that has all the desirable benefits of the Super Elf for so little money. The Super Elf is a small single board computer that does many big things. It is an excellent computer for training and for learning programming with its machine language and yet it is easily expanded with additional memory, Tiny Basic, ASCII Keyboards, video character generator, etc. The Super Elf includes a ROM monitor for program debugging which is not included in others at the same price. With SINGLE STEP you can see the microprocessor chip operating with the unique Quest address and data bus displays before, during and after executing instructions. Also, CPU mode and instruction cycle are shown on several LED indicator lamps.

An RCA 1861 video graphics chip allows you to connect to your own TV with an inexpensive video modulator to do graphics and games. There is a speaker system included for writing your own music or using many music programs already written. The speaker amplifier may also be used to drive relays for control purposes.

A 24 key HEX keyboard includes 16 HEX keys plus load, reset, run, input, memory protect.

Super Expansion Board with Cassette Interface \$89.95

This is truly an astounding value! This board has been designed to allow you to decide how much you want it optioned. The Super Expansion Board comes with 4K of low power RAM fully addressable anywhere in 64K with built-in memory protect and a cassette interface. Provisions have been made for all other options on the same board and it fits neatly into the hardware cabinet alongside the Super Elf. The board includes slots for up to 60K of EPROM (2708, 2756, 2716 or T1 2716) and is fully socketed (\$120.00 value).

Full EPROM can be used for the monitor and Tiny Basic or other purposes. A 1K Super ROM monitor \$19.95 is available as an on board option in 2708 EPROM which has been preprogrammed with a program loader/editor and error checking multi file cassette read/write software, (relocatable cassette file) and/or exclusive from Quest. It includes register save and readout, block move capability, and video graphics driver with blinking cursor. The Super Monitor is written with subroutines allowing users to take advantage of monitor functions

memory select, monitor select and single step. Large, on board displays provide output and optional high and low address. There is a pin standard connector for PC cards and a 50 pin connector for the Quest Super Expansion Board. Power supply and sockets for all IC's are included in the price plus a detailed 50 page instruction manual.

Many schools and universities are using the Super Elf as a course of study. OEM's use it for training and research and development. Remember, other computers only offer Super Elf features at additional cost or not at all. Compare before you buy. Super Elf Kit \$106.95. High address option \$4.95. Low address option \$9.95. Custom Hardware Cabinet with drilled and labelled front panel \$24.95. Nicad Battery Backup Kit \$4.95. All kits and options also completely assembled and tested.

Questdata, a 12 page monthly software publication for 1802 computer users is available by subscription for \$12.00 per year. New 100 page software manual Vol.1 \$4.95.

Tiny Basic for ANY 1802 System

Cassette \$10.00. On ROM \$30.00. The monitor is on ROM. Object code listing or paper tape with manual \$5.50. Original ELF Kit Board \$14.95.

simply by calling them up. Improvements and revisions are easily done with the monitor. If you have the Super Expansion Board and Super Elf, the monitor is up and running at the push of a button.

Other on board options include Parallel Input and Output Ports with full handshake. They allow easy connection of an ASCII keyboard to the input port. RS 232 and 20 mA Current Loop for teletype or other devices are on board and if you need more memory there are two 8-100 slots for static RAM or video boards. A Goldbit 8K RAM board is available for \$15.00. Parallel I/O Ports \$9.95, RS 232 \$4.50, TTY 20 mA I/F \$1.95. \$100-64.50. A 50 pin connector set with ribbon cable is available at \$12.50 for easy connection between the Super Elf and the Super Expansion Board.

The Power Supply for the Super Expansion Board is a 5 amp supply with +8v, +18v +12v -5v. Regulated voltages are +5v & +12v \$29.95. -12 volt optional. Deluxe version includes the case at \$39.95.

Auto Clock Kit \$15.95

Doc clock with 4-50" displays. Uses National MA-1012 module with alarm option. Includes light meter, crystal timebases PC boards. Fully regulated, comp. instructs. Add \$3.95 for beautiful dark gray case. Best value anywhere.

RCA Cosmac VIP Kit \$229.00

Video computer with games and graphics. Fully assembled, and test. \$249.00

Not a Cheap Clock Kit \$14.95

Includes everything except case. 2-PC boards. 6-50" LED Displays. 5314 clock chip, transformer, all components and full instructions. Green and orange displays also avail. Same kit for 60 Hz displays. Ret. only \$21.95. Case \$11.75

60 Hz Crystal Time Base Kit \$4.40

Converts digital clocks from AC line frequency to crystal time base. Outstanding accuracy. Kit includes: PC board, IC, crystal, resistors, capacitors and trimmer.

Digital Temperature Meter Kit

Indoor and outdoor. Switches back and forth. Beautiful. 50" LED readouts. Nothing like it available. Needs no additional parts for complete, full operation. Will measure -100° to +200°F, tenths of a degree, air or liquid. Very accurate. Beautiful woodgrain case w/hazel. \$11.75

NiCad Battery Fizer/Charger Kit

Opens shorted cells that won't hold a charge and then charges them up, all in one kit with parts and instructions. \$7.25

PROM Eraser \$34.50

Ultraviolet, assembled

Clock Calendar Kit \$23.95

CT7015 direct drive chip displays date and time. Uses 47 LEDs with AM-PM indicator. Alarm-drive feature includes buzzer. Complete with all parts, power supply and instructions. Less case.

Same day shipment. First line parts only. Factory tested. Guaranteed money back. Quality IC's and other components at factory prices.

INTEGRATED CIRCUITS

74001N	1	LMC4014	1.15	034011	34	8212	2.80
74002N	17	LMC4014	1.15	034012	34	8213	2.80
74003N	17	LMC4014	1.15	034013	34	8214	2.80
74004N	17	LMC4014	1.15	034014	34	8215	2.80
74005N	17	LMC4014	1.15	034015	34	8216	2.80
74006N	17	LMC4014	1.15	034016	34	8217	2.80
74007N	17	LMC4014	1.15	034017	34	8218	2.80
74008N	17	LMC4014	1.15	034018	34	8219	2.80
74009N	17	LMC4014	1.15	034019	34	8220	2.80
74010N	17	LMC4014	1.15	034020	34	8221	2.80
74011N	17	LMC4014	1.15	034021	34	8222	2.80
74012N	17	LMC4014	1.15	034022	34	8223	2.80
74013N	17	LMC4014	1.15	034023	34	8224	2.80
74014N	17	LMC4014	1.15	034024	34	8225	2.80
74015N	17	LMC4014	1.15	034025	34	8226	2.80
74016N	17	LMC4014	1.15	034026	34	8227	2.80
74017N	17	LMC4014	1.15	034027	34	8228	2.80
74018N	17	LMC4014	1.15	034028	34	8229	2.80
74019N	17	LMC4014	1.15	034029	34	8230	2.80
74020N	17	LMC4014	1.15	034030	34	8231	2.80
74021N	17	LMC4014	1.15	034031	34	8232	2.80
74022N	17	LMC4014	1.15	034032	34	8233	2.80
74023N	17	LMC4014	1.15	034033	34	8234	2.80
74024N	17	LMC4014	1.15	034034	34	8235	2.80
74025N	17	LMC4014	1.15	034035	34	8236	2.80
74026N	17	LMC4014	1.15	034036	34	8237	2.80
74027N	17	LMC4014	1.15	034037	34	8238	2.80
74028N	17	LMC4014	1.15	034038	34	8239	2.80
74029N	17	LMC4014	1.15	034039	34	8240	2.80
74030N	17	LMC4014	1.15	034040	34	8241	2.80
74031N	17	LMC4014	1.15	034041	34	8242	2.80
74032N	17	LMC4014	1.15	034042	34	8243	2.80
74033N	17	LMC4014	1.15	034043	34	8244	2.80
74034N	17	LMC4014	1.15	034044	34	8245	2.80
74035N	17	LMC4014	1.15	034045	34	8246	2.80
74036N	17	LMC4014	1.15	034046	34	8247	2.80
74037N	17	LMC4014	1.15	034047	34	8248	2.80
74038N	17	LMC4014	1.15	034048	34	8249	2.80
74039N	17	LMC4014	1.15	034049	34	8250	2.80
74040N	17	LMC4014	1.15	034050	34	8251	2.80
74041N	17	LMC4014	1.15	034051	34	8252	2.80
74042N	17	LMC4014	1.15	034052	34	8253	2.80
74043N	17	LMC4014	1.15	034053	34	8254	2.80
74044N	17	LMC4014	1.15	034054	34	8255	2.80
74045N	17	LMC4014	1.15	034055	34	8256	2.80
74046N	17	LMC4014	1.15	034056	34	8257	2.80
74047N	17	LMC4014	1.15	034057	34	8258	2.80
74048N	17	LMC4014	1.15	034058	34	8259	2.80
74049N	17	LMC4014	1.15	034059	34	8260	2.80
74050N	17	LMC4014	1.15	034060	34	8261	2.80
74051N	17	LMC4014	1.15	034061	34	8262	2.80
74052N	17	LMC4014	1.15	034062	34	8263	2.80
74053N	17	LMC4014	1.15	034063	34	8264	2.80
74054N	17	LMC4014	1.15	034064	34	8265	2.80
74055N	17	LMC4014	1.15	034065	34	8266	2.80
74056N	17	LMC4014	1.15	034066	34	8267	2.80
74057N	17	LMC4014	1.15	034067	34	8268	2.80
74058N	17	LMC4014	1.15	034068	34	8269	2.80
74059N	17	LMC4014	1.15	034069	34	8270	2.80
74060N	17	LMC4014	1.15	034070	34	8271	2.80
74061N	17	LMC4014	1.15	034071	34	8272	2.80
74062N	17	LMC4014	1.15	034072	34	8273	2.80
74063N	17	LMC4014	1.15	034073	34	8274	2.80
74064N	17	LMC4014	1.15	034074	34	8275	2.80
74065N	17	LMC4014	1.15	034075	34	8276	2.80
74066N	17	LMC4014	1.15	034076	34	8277	2.80
74067N	17	LMC4014	1.15	034077	34	8278	2.80
74068N	17	LMC4014	1.15	034078	34	8279	2.80
74069N	17	LMC4014	1.15	034079	34	8280	2.80
74070N	17	LMC4014	1.15	034080	34	8281	2.80
74071N	17	LMC4014	1.15	034081	34	8282	2.80
74072N	17	LMC4014	1.15	034082	34	8283	2.80
74073N	17	LMC4014	1.15	034083	34	8284	2.80
74074N	17	LMC4014	1.15	034084	34	8285	2.80
74075N	17	LMC4014	1.15	034085	34	8286	2.80
74076N	17	LMC4014	1.15	034086	34	8287	2.80
74077N	17	LMC4014	1.15	034087	34	8288	2.80
74078N	17	LMC4014	1.15	034088	34	8289	2.80
74079N	17	LMC4014	1.15	034089	34	8290	2.80
74080N	17	LMC4014	1.15	034090	34	8291	2.80
74081N	17	LMC4014	1.15	034091	34	8292	2.80
74082N	17	LMC4014	1.15	034092	34	8293	2.80
74083N	17	LMC4014	1.15	034093	34	8294	2.80
74084N	17	LMC4014	1.15	034094	34	8295	2.80
74085N	17	LMC4014	1.15	034095	34	8296	2.80
74086N	17	LMC4014	1.15	034096	34	8297	2.80
74087N	17	LMC4014	1.15	034097	34	8298	2.80
74088N	17	LMC4014	1.15	034098	34	8299	2.80
74089N	17	LMC4014	1.15	034099	34	8300	2.80
74090N	17	LMC4014	1.15	034100	34	8301	2.80
74091N	17	LMC4014	1.15	034101	34	8302	2.80
74092N	17	LMC4014	1.15	034102	34	8303	2.80
74093N	17	LMC4014	1.15	034103	34	8304	2.80
74094N	17	LMC4014	1.15	034104	34	8305	2.80
74095N	17	LMC4014	1.15	034105	34	8306	2.80
74096N	17	LMC4014	1.15	034106	34	8307	2.80
74097N	17	LMC4014	1.15	034107	34	8308	2.80
74098N	17	LMC4014	1.15	034108	34	8309	2.80
74099N	17	LMC4014	1.15	034109	34	8310	2.80
74100N	17	LMC4014	1.15	034110	34	8311	2.80
74101N	17	LMC4014	1.15	034111	34	8312	2.80
74102N	17	LMC4014	1.15	034112	34	8313	2.80
74103N	17	LMC4014	1.15	034113	34	8314	2.80
74104N	17	LMC4014	1.15	034114	34	8315	2.80
74105N	17	LMC4014	1.15	034115	34	8316	2.80
74106N	17	LMC4014	1.15	034116	34	8317	2.80
74107N	17	LMC4014	1.15	034117	34	8318	2.80
74108N	17	LMC4014	1.15	034118	34	8319	2.80
74109N	17	LMC4014	1.15	034119	34	8320	2.80
74110N	17	LMC4014	1.15	034120	34	8321	2.80
74111N	17	LMC4014	1.15	034121	34	8322	2.80
74112N	17	LMC4014	1.15	034122	34	8323	2.80
74113N	17	LMC4014	1.15	034123	34	8324	2.80
74114N	17	LMC4014	1.15	034124	34	8325	2.80
74115N	17	LMC4014	1.15	034125	34	8326	2.80
74116N	17	LMC4014	1.15	034126	34	8327	2.80
74117N	17	LMC4014	1.15	034127	34	8328	2.80
74118N	17	LMC4014	1.15	034128	34	8329	2.80
74119N	17	LMC4014	1.15	034129	34	8330	2.80
74120N	17	LMC4014	1.15	034130	34	8331	2.80
74121N	17	LMC4014	1.15	034131	34	8332	2.80
74122N	17	LMC4014	1.15	034132	34	8333	2.80
74123N	17	LMC4014	1.15	034133	34	8334	2.80
74124N	17	LMC4014	1.15	034134	34	8335	2.80
74125N	17	LMC4014	1.15	034135	34	8336	2.80
74126N	17	LMC4014	1.15	034136	34	8337	2.80
74127N	17	LMC4014	1.15	034137	34	8338	2.80
74128N	17	LMC4014	1.15	034138	34	8339	2.80
74129N	17	LMC4014	1.15	034139	34	8340	2.80
74130N	17	LMC4014	1.15	034140	34	8341	2.80
74131N	17	LMC4014	1.15	034141	34	8342	2.80
74132N	17	LMC4014	1.15	034142	34	8343	2.80
74133N	17	LMC4014	1.15	034143	34	8344	2.80
74134N	17	LMC4014	1.15	034144	34	8345	2.80
74135N	17	LMC4014	1.15	034145	34	8346	2.80
74136N	17	LMC4014	1.15	034146	34	8347	2.80
74137N	17	LMC4014	1.15	034147	34	8348	2.80
74138N	17	LMC4014	1.15	034148	34	8349	2.80
74139N	17	LMC4014	1.15	034149	34	8350	2.80
74140N	17	LMC4014	1.15	034150	34	8351	2.80
74141N	17	LMC4014	1.15	034151	34	8352	2.80
74142N	17	LMC4014	1.15	034152	34	8353	2.80
74143N	17	LMC4014	1.15	034153	34	8354	2.80
74144N	17	LMC4014	1.15	034154	34	8355	2.80
74145N	17	LMC4014	1.15	034155	34	8356	2.80
74146N	17	LMC4014	1.15	034156	34	8357	2.80
74147N	17	LMC4014	1.15	034157	34	8358	2.80
74148N	17	LMC4014	1.15	034158	34	8359	2.80
74149N	17	LMC4014	1.15	034159	34	8360	2.80
74150N	17	LMC4014	1.15	034160	34	8361	2.80
74151N	17	LMC4014	1.15	034161	34	8362	2.80
74152N	17	LMC4014	1.15	034162	34	8363	2.80
74153N	17	LMC4014	1.15	034163	34	8364	2.80
74154N	17	LMC4014	1.15	034164	34	8365	2.80
74155N	17	LMC4014	1.15	034165	34	8366	2.80
74156N	17	LMC4014	1.15	034166	34	8367	2.80
74157N	17	LMC4014	1.15	034167	34	8368	2.80
74158N	17	LMC4014	1.15	034168	34	8369	2.80
74159N	17	LMC4014	1.15	034169	34		

AMAZING EARADIO

THIS IS PROBABLY THE WORLD'S SMALLEST RADIO. IT MEASURES ONLY 1 1/2 INCHES AND IS WORKING BEHIND THE EAR. CONTAINS AN IC AND SEVERAL DISCRETE DEVICES TO GIVE AN EQUIVALENT OF 12 TRANSISTORS. THE RADIO HAS A DESIGN OPERATING FROM 1 STANDARD SIZE 1.5V HEARING AID BATTERY (INCLUDED). IT PROVIDES SOUND VOLUME TO EARPHONE OR SEVERAL STATIONS IN METROPOLITAN AREAS. DOESN'T REQUIRE AN ANTENNA, CORDING OR OTHER ADDITIONAL WIRES - FULLY SELF-CONTAINED & UNUSABLE. SIZE: 1 1/2" x 1 1/4" x 3/8".

Crystal 14.04 Mhz Oscillator
IC clock oscillator
C23289 \$1.98

SEND FOR YOUR
FREE 1979 CATALOG

NEW DESIGN
CIRCUITS
C23289 \$1.98

NEW DESIGN
CIRCUITS
C23289 \$1.98

Electronic Warning Flasher Kit

This battery operated device continuously emits bursts of intense light. Great safety device for bicycle riders, skiers, hikers, boaters & campers. Comes complete w/ all electronic parts, quality glass-epoxy P.C. boards & easy to understand instructions. Uses high-output xenon flash tube which flashes 2 times per second when batteries are fresh. Operates continuously for 12 hours on 2 alkaline "C" cells. No need only to supply the batteries and, if desired, a battery holder & case.

C23207 \$6.95
(3 for \$18.00)

Strobe Light Kit

Strobe Light Kit
C23208 \$3.00

6 HV TRIGGER

6 HV TRIGGER
C23208 \$3.00

Green Neon

Green Neon
C23207 \$6.95

PHOTOFAX/IC CARD

350 ml 330V 100
720 ml 360V 150
1600 ml 360V \$2.25

CALCULATOR BOARDS

CALCULATOR BOARDS
C23227 \$1.00

STROBE TUBE KIT

STROBE TUBE KIT
C23280 \$3.00

MINIATURE REFLECTOR

MINIATURE REFLECTOR
C23227 \$1.00

CHANEY Electronics

CHANEY Electronics
P.O. BOX 27038, DENVER, CO. 80227 Ph: (303) 751-5750

Send for our FREE GIANT CATALOG of unique items!

Now, more than ever
...Men who KNOW say...



IS THE ANSWER

HELP NATESA HELP YOU
BY DOING YOUR PART

Are YOU the operator of an ethical, professional caliber tv-radio-home electronics service business?

Write for details on how you can gain great benefits and participate in the destinies of this great industry.

NATESA

5908 South Troy Street
Chicago, Illinois 60629

ADVERTISING INDEX

RADIO-ELECTRONICS does not assume any responsibility for errors that may appear in the index below.

Free Information Number Page

33	Active Electronics	101
—	Advance Electronics	26, 79 & 83
16	Advanced Computer Products	118
—	A M C Sales	98
19	American Antenna	Cov. 4
63	Antenna Incorporated	22 & 23
62	A P Products, Inc.	81
11	A V R Electronics	114
—	Karel Barta	100
56	B & K Precision Dynascan Co.	86
—	Bullett Electronics	100
—	Burdex Security Co.	98
51	C F R Associates	102
—	Chaney Electronics	122
—	CIE-Cleveland Institute of Electronics	18-21
—	Command Productions	106
25	Continental Specialties	Cov. 3
41	The Cooper Group Electronics Division	7
—	C R E I - Div. of McGraw Hill Continuing Ed.	70-73
—	Dage Scientific Instruments	98
64	Davis Electronics	87
14	Delta Electronics	106
70	Diamondback Electronics	108
59	Digi - Key	119
—	DRC-Digital Research Corporation	102
26	E I C O	96
35	Electronics	85
23	Electronics Book Club (Tab Books)	25
40	Electronic Development Lab	102
40	Electronic Supermarket	100
71	Electronic Systems	117
—	Electro - Voice, Inc.	82
—	E M C - Electronics Measurements	95
29	Enterprise Development	96
46, 47 & 72	Fluke	32 & 75
42	Fordham Radio Supply	120
13	Formula International	104 & 105
—	Fowler Alarms	98
—	Fuji - Sves	99
—	Gavin Instruments	95
—	G. E. - General Electric	27
—	Gilfer Shortwave	106
28	Godbout Electronics	112
—	Golden Enterprises	98
7	Gould	Cov. 2
17	Grantham College of Engineering	92
36	Graymark	115
100	Heath	88-91
69	Hickok Electrical Instruments	17
44	Hobby World	114
48	I E Intergrated	114
—	Indiana Home Study	102
—	Information Unlimited	97
60	International Crystal Mfg. Co.	87
24	International Instrumentation	108
9, 10	James Electronics	35, 110 & 111
—	Jensen Tools & Alloys	92
3	Kester Solder	84
—	Lakeside Industries	100
52	McKay Dymek	14
32	Mesma	114
—	Millico Industries	98
27	M T I-Mobile Training Institute	95

5	National Camera Supply	94
—	National Radio Inst. (NRI) Div. of McGraw Hill	8-11
—	National Technical Schools	28-31
58	Netronics	93
43	New-Tone Electronics International	108
15	Ohio Scientific	1
—	Olson	98
6	Optoelectronics	116
67	P A I A	93
54	Panavise	96
61	Platt Luggage	16
34	Poly Paks	113
37	Pomona	36
38	President Electronics	Cov. 2
66	P T S Electronics	112
45	Quest	121
8	Quintrinox	106
103	Radio Shack	103
39	Ramsey Electronics	107
—	R C A	76 & 77
22	Rye Industries	16
—	Sabtronic	15
31	Schober Organ	75
2	Shure Brothers	33
57	Soar	85
21	Solid State Sales	112
68	Southwest Technical Products	94
—	Speakerlab, Inc.	97
—	Starshine	13
—	Tasco	98
18	Trinico International	109
12	Tri-Star	102
—	Tri-Tek	97
—	Trumbull	97
55	Vector	24
49	Viz Mfg.	34
20	Versi Electronics	122
30	Zemco	5

MOVING?

Don't miss a single copy of **Radio-Electronics**. Give us:

Six weeks' notice

Your old address and zip code

Your new address and zip code

ATTACH
LABEL
HERE

name (please print)

address

city state zip code

Mail to: Radio-Electronics
SUBSCRIPTION DEPT., P.O. BOX 2520,
BOULDER, CO. 80322

How to be in 16 places at once. Logically.



Meet CSC's Logic Monitor LM-1. The fastest, most efficient way to check digital DIP IC's. A self-powered, precision instrument that automatically senses and displays the static and dynamic states of every node on any DIP up to 16 pins *at once*. Instantly. Accurately. And *safely*. Speeds design and testing on all types of DTL, TTL, HTL and CMOS logic.

Use LM-1 to trace signals through counters, shift registers, gating networks, flip-flops, decoders ... any type of circuit or system, even with mixed logic families. Cutting minutes—often hours—from design, development, debugging, production testing, QC, field service and repair.

Nothing could be simpler to use. Just clip it over any DIP up to 16 pins, and the LM-1 does the rest. Precision plastic guides and unique flexible web

insure positive connections between non-corrosive nickel-silver contacts and IC leads. Each contact connects to a single "bit" detector with high-intensity LED readout, activated when the applied voltage level exceeds a fixed 2V threshold. Logic "1" (high voltage) turns LED on; Logic "0" (low voltage or open circuit) keeps LED off. A power-seeking gate network automatically locates supply leads and feeds them to the Logic Monitor's internal circuitry.

Very clever. Very portable. Very effective. And very reasonable, at \$59.95* Order today.

NEED MORE INFORMATION? CALL 203-624-3103 to order, or for the name of your local distributor. Prices slightly higher outside USA.

CONTINENTAL SPECIALTIES CORPORATION

Corporate Headquarters:
Continental Specialties Corporation
70 Fulton Terrace, Box 1942, New Haven, CT 06509
351 California St., San Francisco, CA 94104
(415) 421-8872, TWX 910-372-7992



Europe, Africa, Mid-East: CSC UK LTD.
Shire Hill Industrial Estate, Units 1 and 2
Saffron Walden, Essex CB 11 3AQ
Telephone: SAFFRON WALDEN 21682
Telex: 817477

*1978, Continental Specialties Corporation. *Manufacturer's suggested retail. Prices, subject to change without notice.

CIRCLE 25 ON FREE INFORMATION CARD

New, K40 Magnamount: Grips like a grapple, actually improves transmission.



We double guarantee it*

Exclusive Octopole Construction.



That's eight magnets set in eight different directions to give you a magnetic seal so complete and powerful, your antenna would stay up there if you could squeeze between two semis passing each other at 180 miles an hour. That's magnetic octopower.

* GUARANTEE I

Placed on the roof of a vehicle; properly tuned, the K40 Magnamount is guaranteed to transmit a further distance than a standard K40 without the Magnamount or you will receive a prompt and full refund from your K40 dealer who installed and tuned the Magnamount K40 for you.

* GUARANTEE II

Materials and workmanship are guaranteed for a full 12 months. Any part that fails to perform satisfactorily will be replaced absolutely free.

Exclusive K40 Flux Harmonics for Greater Transmission.

The magnetic radiation pattern was designed to match the K40 antenna radiation for greater distance than the standard K40. See our guarantee.

The facts: Physics and Physical.

1. Magnamount is a bigger, stronger magnet—in fact it's 8 bigger, stronger, magnets.
2. It doesn't just hold the K40 antenna, it helps it transmit further.
3. Remember the law of reciprocity. The antenna that transmits better, receives better.
4. It provides a flatter, lower SWR because the Magnamount is capacitance grounded.
5. It puts your $\frac{5}{8}$ wave K40 antenna securely in place in the most advantageous place to work against a ground plane—high and free from obstruction. That's square in the middle, right up on top.

\$15.95 buys it.

(SUGGESTED RETAIL)

K40 Magnamount.

American Antenna 1945 South Street Elgin, Illinois 60120

This professional CB equipment available only through Registered K40 Dealers!

CIRCLE 19 ON FREE INFORMATION CARD